Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Mechanical System Harmonization Working Group
Task 2 – Harmonize 14 CFR Parts 25.677(b), 25.729, 25.433(b)(2), 25.443(4), 25.1439, 25.821(b)

Task Assignment

[Federal Register: November 26, 1999 (Volume 64, Number 227)]
[Notices]
[Page 66522-66524]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr26no99-123]

==========

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues--New and Revised Tasks

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new and revised task assignments for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of new tasks assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC) and of revisions to a number of existing tasks. This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Dorenda Baker, Transport Airplane Directorate, Aircraft Certification Service (ANM-110), 1601 Lind Avenue, SW., Renton, WA 98055; phone (425) 227-2109; fax (425) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is transport airplane and engine issues. These issues involve the airworthiness standards for transport category

[[Page 66523]]

airplanes and engines in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135. The corresponding Canadian standards are contained in Parts V, VI, and VII of the Canadian Aviation Regulations. The corresponding European standards are contained in Joint Aviation Requirements (JAR) 25, JAR-E, JAR-P, JAR-OPS-Part 1, and JAR-26.

As proposed by the U.S. and European aviation industry, and as

agreed between the Federal Aviation Administration (**FAA**) and the European Joint Aviation Authorities (JAA), an accelerated process to reach harmonization has been adopted. This process is based on two procedures:

(1) Accepting the more stringent of the regulations in Title 14 of the Code of Federal Regulations (FAR), Part 25, and the Joint Airworthiness Requirements (JAR); and

(2) Assigning approximately 41 already-tasked significant regulatory differences (SRD), and certain additional part 25 regulatory differences, to one of three categories:

<bullet> Category 1--Envelope
<bullet> Category 2--Completed or near complete
<bullet> Category 3--Harmonize

The Revised Tasks

ARAC will review the rules identified in the ``FAR/JAR 25 Differences List,'' dated June 30, 1999, and identify changes to the regulations necessary to harmonize part 25 and JAR 25. ARAC will submit a technical report on each rule. Each report will include the cost information that has been requested by the **FAA**. The tasks currently underway in ARAC to harmonize the listed rules are superseded by this tasking.

New Tasks

The **FAA** has submitted a number of new tasks for the Aviation Rulemaking Advisory Committee (ARAC), Transport Airplane and Engine Issues. As agreed by ARAC, these tasks will be accomplished by existing harmonization working groups. The tasks are regulatory differences identified in the above-referenced differences list as Rule type = P-SRD.

New Working Group

In addition to the above new tasks, a newly established Cabin Safety Harmonization Working Group will review several FAR/JAR paragraphs as follows:

ARAC will review the following rules and identify changes to the regulations necessary to harmonize part 25 and JAR:

(1) Section 25.787;
(2) Section 25.791(a) to (d);
(3) Section 25.810;
(4) Section 25.811;
(5) Section 25.819; and
(6) Section 25.813(c).

ARAC will submit a technical report on each rule. Each report will include the cost information that has been requested by the **FAA**.

The Cabin Safety Harmonization Working Group would be expected to complete its work for the first five items (identified as Category 1 or 2) before completing item 6 (identified as Category 3).

Schedule

Within 120 days of tasking/retasking:

<bullet> For Category 1 tasks, ARAC submits the Working Groups' technical reports to the **FAA** to initiate drafting of proposed rulemaking documents.

<bullet> For Category 2 tasks, ARAC submits technical reports, including already developed draft rules and/or advisory materials, to the **FAA** to complete legal review, economic analysis, coordination, and issuance.

June 2000: For Category 3 tasks, ARAC submits technical reports including draft rules and/or advisory materials to the **FAA** to complete legal review, economic analysis, coordination, and issuance.

ARAC Acceptance of Tasks

ARAC has accepted the new tasks and has chosen to assign all but one of them to existing harmonization working groups. A new Cabin Safety Harmonization Working Group will be formed to complete the remaining tasks. The working groups serve as staff to ARAC to assist ARAC in the analysis of the assigned tasks. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts a working group's recommendations, it forwards them to the **FAA** and ARAC recommendations.

Working Group Activity

All working groups are expected to comply with the procedures adopted by ARAC. As part of the procedures, the working groups are expected to accomplish the following:

1. Document their decisions and discuss areas of disagreement, including options, in a report. A report can be used both for the enveloping and for the harmonization processes.

2. If requested by the **FAA**, provide support for disposition of the comments received in response to the NPRM or review the **FAA**'s prepared disposition of comments. If support is requested, the Working Group will review comments/disposition and prepare a report documenting their recommendations, agreement, or disagreement. This report will be submitted by ARAC back to the **FAA**.

3. Provide a status report at each meeting of ARAC held to consider Transport Airplane and Engine Issues.

Partcipation in the Working Groups

Membership on existing working groups will remain the same, with the formation of subtask groups, if appropriate. The Cabin Safety Harmonization Working Group will be composed of technical experts having an interest in the assigned task. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the Cabin Safety Harmonization Working Group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the tasks, and stating the expertise he or she would bring to the working group. All requests to participate must be received no later than December 30, 1999. The requests will be reviewed by the assistant chair, the assistant executive director, and the working group chair, and the individuals will be advised whether or not the request can be accommodated.

Individuals chosen for membership on the Cabin Safety Harmonization Working Group will be expected to represent their aviation community segment and participate actively in the working group (e.g., attend all meetings, provide written comments when requested to do so, etc.). They also will be expected to devote the resources necessary to ensure the ability of the working group to meet any assigned deadline(s). Members are expected to keep their management chain advised of working group activities and decisions to ensure that the agreed technical solutions do not conflict with their sponsoring organization's position when the subject being negotiated is presented to ARAC for a vote.

Once the working group has begun deliberations, members will not be added or substituted without the approval of the assistant chair, the assistant executive director, and the working group chair.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

[[Page 66524]]

Meetings of ARAC will be open to the public. Meetings of the working groups will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on November 19, 1999.

Anthony F. Fazio,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 99-30774 Filed 11-24-99; 8:45 am]
BILLING CODE 4910-13-M

Recommendation Letter

- 200

400 Main Street
East Hartford, Connecticut 06108

Pratt & Whitney
A United Technologies Company

June 1, 2000

Department of Transportation
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Attention: ✓Mr. Anthony Fazio, ARM-1

Subject: ARAC Report Submittal

Reference: ARAC Tasking, Federal Register, November 19, 1999

Dear Tony,

In accordance with the reference tasking, the ARAC Transport Airplane and Engine Issues Group is pleased to submit the following "Fast Track" reports as ARAC recommendations.

- 25.773 Pilot Compartment View ANM-00-085-A TASK #2
- 25.677 Trim Systems "

These reports have been prepared by the Mechanical Systems Harmonization Working Group of TAEIG.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant [redacted]

Copy: [redacted] - FAA-NWR
*Effie [redacted] - FAA-ARM-209
*P. Waters - Boeing

*letter only

CRB001_060100

Recommendation

ARAC WG Report Format

1 - What is underlying safety issue addressed by the FAR/JAR? [redacted]

Loss of pilot view through flight deck transparencies in precipitation due to the environmental conditions or due to system failures can lead to unsafe conditions. The FAR/JAR 25.773(b) rules define design requirements for flight deck window heat and rain removal systems to ensure reliable and safe operation during these precipitation conditions.

2 - What are the current FAR and JAR standards? [redacted]

FAA REQUIREMENTS

14 Code of Federal Regulations 25.773

§ 25.773 Pilot Compartment View.

(b) Precipitation conditions. For precipitation conditions, the following apply:

(1) The airplane must have a means to maintain a clear portion of the windshield, during precipitation conditions, sufficient for both pilots to have a sufficiently extensive view along the flight path in normal flight attitudes of the airplane. This means must be designed to function, without continuous attention on the part of the crew, in-

(i) Heavy rain at speeds up to 1.6 V_{s1} with lift and drag devices retracted; and

(ii) The icing conditions specified in §25.1419 if certification with ice protection provisions is requested.

(2) The first pilot must have-

(i) A window that is openable under the conditions prescribed in paragraph (b)(1) of this section when the cabin is not pressurized, provides the view specified in that paragraph, and gives sufficient protection from the elements against impairment of the pilot's vision; or

(ii) An alternate means to maintain a clear view under the conditions specified in paragraph (b)(1) of this section, considering the probable damage due to a severe hail encounter.

[Amdt. 25-72, 55 FR 29778, July 20, 1990]

Advisory Circular No. 25.773-1 Pilot Compartment View Design Considerations.

Date: January 8, 1993

1. PURPOSE. This advisory circular (AC) sets forth a method for demonstrating compliance with the airworthiness standards for transport category airplanes pertaining to pilot compartment view. As with all AC material, it is not mandatory and does not constitute a regulation. It is for guidance purposes only.

2. RELATED DOCUMENTS.

a. Federal Aviation Regulations (FAR). The related sections of Part 25 include:

§ 25.237 Wind velocities
§ 25.773 Pilot compartment view
§ 25.775 Windshields and windows
§ 25.777 Cockpit controls (seat for pilots from 5'2" to 6'3" in height, in consideration of the design eye position).

b. Industry Documents. The following documents are available from the Society of Automotive Engineers, Inc. (SAE), 400 Commonwealth Drive, Warrendale, PA 15096:

ARP 268G Location and Actuation of Flight Deck Controls for Transport Airplanes.
ARP 4101/1 Seats and Restraint Systems for the Flight Deck.
ARP 4101/2 Pilot Visibility from the Flight Deck.

3. BACKGROUND.

a. On January 19, 1971, the FAA issued Notice of Proposed Rulemaking No. 71-2, Cockpit Vision and Cockpit Controls. This notice proposed amendments to the airworthiness standards for transport category airplanes that introduced comprehensive cockpit vision standards and changed the range of pilot heights used for the location and arrangement of cockpit controls. A majority of the commenters responding to Notice 71-2 objected to the proposed amendments. In general, the airplane manufacturers believed the proposed requirements were too stringent and exceeded the state-of-the-art, particularly with respect to the size of transparent panels, considering weight and structural strength necessary to provide clear vision in the specified areas. The manufacturing industry, represented by the Transport Airworthiness Requirements Committee (TARC) of the Aerospace Industries Association, maintained that the proposed size of the clear vision field was in excess of that required to meet the most important objective of the proposed standards. That objective was to provide optimum vision for avoidance of midair collisions in "see and be seen" conditions of flight. The committee carried out a computerized study program that considered 10,000,000 hypothetical cases of pairs of airplanes on collision courses considering reasonable airplane mixes of type, speed, flight path angles, bank angles, etc. In addition, all known available data from actual midair collisions, reported near misses, and USAF Hazardous Air Traffic Reports (HATR) were used.

b. The pilot compartment view that evolved from the TARC study was somewhat smaller and its area redistributed in comparison with existing CAM 4b.350 recommendations and those proposed in Notice 71-2. The FAA withdrew the proposed rulemaking based on the information presented. Subsequent to that withdrawal, the Society of Automotive Engineers Inc. (SAE), Committee S-7, adopted the TARC recommendation as Aerospace Standard AS 580B. The FAA has adopted the TARC/SAE pilot compartment view for this advisory circular. Some of the SAE criteria have been modified and adopted as guidance for validating the pilot compartment view. Users of this circular should bear in mind that the pilot compartment view described herein is that which the TARC study showed to be minimum for collision avoidance. Designers are urged to provide the maximum practicable capability in excess of this field of view.

c. It is the responsibility of the applicant to show by acceptable means that the proposed arrangement meets the requirements of accessibility and non-interference set forth by § 25.777. Designers and certification authorities are encouraged to refer to guidance in current Aerospace Recommended Practice ARP 268G and ARP 4101/1 (replaces AS 290B) for these considerations. These documents were also prepared by the SAE for use in conjunction with ARP 4101/2 (replaces AS 580B).

4. CRITERIA FOR PILOT COMPARTMENT VISIBILITY.

a. The flight deck windshield must provide sufficient external vision to permit the pilot to safely perform any maneuvers within the operating limits of the aircraft and, at the same time, afford an unobstructed view of the flight instruments and other critical components and displays from the same eye position. The following subparagraphs describe the minimum criteria for pilot compartment view. Aircraft designers and manufacturers should make every effort to build windshields that offer the pilot more external vision.

b. Design Eye Position. The design eye position is a single point selected by the applicant that meets the requirements of §§ 25.773(d) and 25.777(c) for each pilot station. Figure 1 depicts a design eye position and pilot compartment view for optimum collision avoidance potential for the left pilot seat. For the right pilot seat, all left/right dimensions are reversed.

Figure 1. Pilot Compartment View (figure not reproduced here)

Figure 2. Measurement of Angles (figure not reproduced here)

c. Clear Areas of Vision. The clear areas of vision should be determined by measurement of angles from the design eye position utilizing ambinocular vision. Ambinocular vision is the total area that can be seen by both eyes. It is not limited to the binocular field but includes, in addition, monocular regions visible to the right eye, but not to the left, and vice versa. Measurements are made as depicted in figure 2 with an

intraocular distance of 63.6 mm (2 1/2 inches) and utilizing rotational motion in a horizontal plane about a central axis 84 mm (3 5/16 inches) aft of the design eye position. These dimensions correspond to average cranial dimensions for humans. The horizontal and vertical vision angles should be measured from: (1) a vertical datum plane running fore and aft through the design eye point and central axis; and (2) a horizontal datum plane perpendicular to the vertical plane that also passes through the design eye point and central axis. The vertical and horizontal datum planes are fixed relative to the airplane and should be parallel to those corresponding to zero pitch and yaw angles for the airplane. With the design eye position located per paragraph 4b, the vision through the transparent areas should provide the following pilot compartment view:

(1) Forward and up 35 degrees from the horizontal datum plane at 40 degrees left of the vertical datum plane, diminishing linearly to 15 degrees up at 20 degrees right.

(2) Forward and down 17 degrees from the horizontal datum plane between 30 degrees left and 10 degrees right of the vertical datum plane, diminishing linearly to 10 degrees down at 20 degrees right.

(3) Forward and up 35 degrees from the horizontal datum plane between 40 degrees left and 80 degrees left of the vertical datum plane, diminishing linearly to 15 degrees up at 120 degrees left.

(4) Forward and down 17 degrees from the horizontal datum plane at 30 degrees left of the vertical datum plane, diminishing linearly to 27 degrees down at 70 degrees left.

(5) Forward and down 27 degrees from the horizontal datum plane between 70 degrees left and 95 degrees left of the vertical datum plane, diminishing linearly to 15 degrees down at 120 degrees left.

d. Landing Vision. In addition to the requirements of paragraph 4c, the view angle forward and down should be sufficient to allow the pilot to see a length of approach and/or touch-down zone lights that would be covered in three seconds at landing approach speed when the aircraft is:

(1) On a 2 1/2 degree glideslope.

(2) At a decision height that places the lowest part of the aircraft at 30.5 m (100 feet) above the touch-down zone extended horizontally.

(3) Yawing to the left to compensate for ten knots crosswind.

(4) Loaded to the most critical weight and center of gravity.

(5) Making the approach with 366 m (1200 feet) runway visual range (RVR).

e. Obstructions to Vision.

(1) There should be no obstructions to vision between 20 degrees right and 20 degrees left in the vision polar depicted by figure 1. Obstructions outside this 40 degree area should be kept to a minimum; ideally not more than three (i.e., center post, forward post, and side post). Using ambinocular vision, it should be possible for a pilot to have vision of any given bearing that is blocked to the other pilot from 80 degrees right to 80 degrees left of the design eye position. In addition, it is desirable that obstructions be eliminated by using ambinocular vision with the average human intraocular dimensions of 63.6 mm (2 1/2 inches). This would require that the projected width of the obstruction be no greater than the intraocular dimension. It should be possible for the pilot to eliminate any obstruction to vision using ambinocular vision with head movement of 13 mm (1/2 inch) left and right. In the example depicted in figure 2, head movement to the left would eliminate the obstacle. Use of sun visors that reduce light transmissivity are acceptable; however, totally opaque visors that impinge upon the field of view of figure 1 should not be used.

(2) Windows and windshields that have become deteriorated in service are considered to be airworthy only if the pilot compartment view is not impaired below the criteria set forth in paragraph e(1).

f. Optical Properties. The windshield should exhibit optical properties equivalent to those specified in MIL-P-25374B for plastic windows, and MIL-G-25871B for glass or glass-plastic windows. These documents contain information on laminate construction, optical uniformity, luminous transmittance, physical properties, environmental exposure, etc.

g. Precipitation. Precipitation clearing should be provided for the windshield panels directly forward of each pilot and should be effective at all thrust settings up to at least 1.6 V_s (clean) or 230 knots, whichever is less. The minimum area to be cleared should be 15 degrees left to 15 degrees right of the design eye position, upward to the horizon during the steepest approach path expected in operation, and downward to the limits recommended in paragraph 4c. If windshield wipers are used, wiper speeds of approximately two sweeps per second have been found to be satisfactory in maintaining a cleared area.

h. Compliance Considerations. A method traditionally used for showing compliance with the vision requirements has been a somewhat exotic camera system. Other methods are also allowed, including 3-D graphics systems and simple surveying equipment. The formation of the vision boundaries described in this advisory circular is based on flight at subsonic speeds. Any aircraft featuring variable nose geometry, or those capable of making STOL/VSTOL steep approaches, should be subject to special compliance considerations.

JAA REQUIREMENTS

JAR 25.773 Pilot compartment view

(b) Precipitation conditions. For precipitation conditions, the following apply:

(1) The aeroplane must have a means to maintain a clear portion of the windshield during precipitation conditions, sufficient for both pilots to have a sufficiently extensive view along the flight path in normal flight attitudes of the aeroplane. This means must be designed to function, without continuous attention on the part of the crew, in--

(i) Heavy rain at speeds up to 1.6 [$V_{S(1)}$, with lift and drag devices retracted; and]

(ii) The icing conditions specified in JAR 25.1419 if certification with ice protection provisions is requested. (See ACJ 25.773(b)(1)(ii).)

(2) No single failure of the systems used to provide the view required by sub-paragraph (b)(1) of this paragraph must cause the loss of that view by both pilots in the specified precipitation conditions.

[(3) The first pilot must have --

(i) A window that is openable under the conditions prescribed in subparagraph (b)(1) of this paragraph when the cabin is not pressurised, provides the view specified in that paragraph, and gives sufficient protection from the elements against impairment of the pilot's vision; or

(ii) An alternate means to maintain a clear view under the conditions specified in sub-paragraph (b)(1) of this paragraph, considering the probable damage due to a severe hail encounter.]

(4) The openable window specified in sub-paragraph (b)(3) of this paragraph need not be provided if it is shown that an area of the transparent surface will remain clear sufficient for at least one pilot to land the aeroplane safely in the event of--

(i) Any system failure or combination of failures which is not Extremely Improbable under the precipitation conditions specified in sub-paragraph (b)(1) of this paragraph.

(ii) An encounter with hail, birds or insects.

[Change 14 27.5.94]

Advisory Circular Joint (ACJ) 25.773(b)(1)(ii) - Pilot Compartment View (Acceptable Means of Compliance)

See JAR 25.773(b)(1)(ii)

For windshields protected by the application of electrical heat, a nominal heating capacity of 70 W/dm^2 would be adequate.

In mid-1998 the JAA released a Notice of Proposed Amendment (NPA) 25D-269 intended to clarify JAR 25.773(b). The NPA would have partially harmonized the JAR and FAR requirements by deleting JAR 25.773(b)(4) and making other minor wording changes. It would also have introduced a new Advisory Circular Joint (ACJ) 25.773(b)(3)(ii). The NPA was circulated for comments within the JAA but is now on hold pending the outcome of this ARAC working group effort, and it is anticipated that the proposed NPA will be superseded by the proposed harmonized FAR/JAR standard presented herein.

3 - What are the differences in the standards and what do these differences result in?:

[redacted]

The first difference in FAR and JAR 25.773(b) is in subparagraph (b)(1)(ii). The actual requirement statement is the same, that is to meet the icing requirements of FAR/JAR 25.1419 for windshield visibility. JAR 25.773(b)(1)(ii), however, refers to ACJ 25.773(b)(1)(ii), which supplements JAR 25.773(b)(1)(ii) by specifying a nominal heating capacity of 70 Watts per square decimeter as a means of compliance. Although the JAR provides additional information and a means of compliance, it is not necessarily more stringent than the FAR, because both the FAR and the JAR refer back to 25.1419, which in turn refer to FAR/JAR Appendix C meteorological icing envelopes. These envelopes contain icing conditions for which a particular windshield or transparency design, using the power density of 70 W/dm^2 specified in the ACJ, may not provide adequate anti-icing heat. Therefore, the FAR and JAR are actually more stringent by refering to Appendix C and not to the ACJ.

The next, and much more significant, difference in terms of compliance and aircraft design, is JAR 25.773(b)(2), which is an additional requirement, not equivalent with FAR 25.773(b)(2). The JAR adds the requirement that no single failure of the system specified in 25.773(b)(1) i.e. the rain removal system, can lead to a loss of pilot view through both windshields. The effect of this requirement on airplane design is that separate, mechanically and electrically independent windshield wiper systems must be provided, including separate flight deck control switches for left and right windshield wipers. In this case, the JAR is more stringent than the FAR, and provides for an increased system reliability, and an increased level of safety.

FAR 25.773(b)(2) is equivalent to JAR 25.773(b)(3). There are no design or compliance differences between these two sections.

The final difference is the addition of JAR 25.773(b)(4), which is unique and does not have an equivalent FAR. This section, which allows for an alternative to an openable side window required in the previous section, can be interpreted to be redundant with FAR 25.773(b)(2)(ii) and JAR 25.773(b)(3)(ii), but provides more detail to the requirements. JAR 25.773(b)(4) contains two subparagraphs. JAR 25.773(b)(4)(i) allows relief for the openable side window if it can be demonstrated that sufficient pilot view is still provided, even in the event of a failure or combination of failures of the rain removal system, where the failure(s) is not extremely improbable. This basically implies that if there is a dual windshield wiper system failure (which is typically not extremely improbable), the openable side window is still not required if adequate vision can still be maintained through the windshield or side window. This is more restrictive than the FAR because the alternate means of vision in the FAR could be interpreted to be the windshield wipers, whereas the JAR considers that the wipers may be failed so they cannot be the alternate means of visibility.

In terms of advisory material relative to the FAR and JAR standards, the FAA AC 25.773-1 provides extensive definition of what constitutes sufficient pilot visibility through the windshield. The JAR does not have equivalent advisory material. The AC also includes suggested means of compliance for windshield wiper speed. The ACJ, as previously mentioned however, includes suggested means of compliance for window heat system performance, which is not covered in the AC.

4 - What, if any, are the differences in the means of compliance? [redacted]

The only difference in compliance with FAR/JAR 25.773(b) is the addition of a second wiper switch, based on the additional JAR requirement in JAR 25.773(b)(2). Compliance to the FAR can be demonstrated with only one wiper switch to control both left and right wipers, but the JAR specifically requires provisions to preclude the potential failure of both systems due to a single fault. Therefore, the system design is driven to have separate left and right wiper switches in addition to separate motors.

The reference to hail, birds and insects in JAR 25.773(b)(4) has not been specifically demonstrated in any manner different than that for FAR 25.773(b)(2)(ii), which only specifies severe hail. Compliance to FAR 25.773(b)(2)(ii), JAR 25.773(b)(4)(i) and 25.773(b)(4)(ii) has typically been demonstrated by compliance statement, system description or analysis only.

5 – What is the proposed action? [redacted]

The proposed action is to merge the requirements of both FAR and JAR rules, to compare these requirements with industry standards and to simplify the rule by using the industry

standards which have resulted in systems that have been demonstrated safe by service experience. The harmonized rule will combine the requirements of FAR 25.773(b) and JAR 25.773(b) into one harmonized rule and eliminate the need for the ACJ 25.773(b)(1)(ii). This method was chosen after an investigation of rule contents and applications of JAR 25.773(b) and ACJ 25.773(b)(1)(ii) in state-of-the-art-design. The harmonized rule is in line with industry standards which have resulted in systems that have been demonstrated safe by aircraft certifications and service experience.

It is also recommended that the AC 25.773-1 be retained with no changes. The AC supplements the FAR while not contradicting the JAR. It contains extensive details on sufficient pilot visibility through the windshield, but does not go into detail in the areas that are affected for harmonization of the FAR and JAR.

The resulting harmonization will incorporate the more stringent requirements of the JAR but will include simplified wording to make the new rule easier to understand and less likely to be misinterpreted.

6 - What should the harmonized standard be? [redacted]

25.773 Pilot compartment view

(b) Precipitation conditions. For precipitation conditions, the following apply:

(1) The airplane must have a means to maintain a clear portion of the windshield during precipitation conditions, sufficient for both pilots to have a sufficiently extensive view along the flight path in normal flight attitudes of airplane. This means must be designed to function, without continuous attention on the part of the crew, in--

(i) Heavy rain at speeds up to 1.6 V_{S1}, with lift and drag devices retracted; and

(ii) The icing conditions specified in [FAR or JAR] 25.1419 if certification with ice protection provisions is requested.

(2) No single failure of the systems used to provide the view required by sub-paragraph (b)(1) of this paragraph must cause the loss of that view by both pilots in the specified precipitation conditions.

(3) The first pilot must have a window that is openable under the conditions prescribed in subparagraph (b)(1) of this paragraph when the cabin is not pressurized, provides the view specified in that paragraph, and gives sufficient protection from the elements against impairment of the pilot's vision.

(4) The openable window specified in sub-paragraph (b)(3) of this paragraph need not be provided if it is shown that an area of the transparent surface will remain clear sufficient for at least one pilot to land the airplane safely in the event of--

(i) Any system failure or combination of failures which is not Extremely Improbable, in accordance with [FAR or JAR] 25.1309, under the precipitation conditions specified in sub-paragraph (b)(1) of this paragraph.

(ii) An encounter with severe hail, birds or insects.

The AC 25.773-1 should be retained with no revisions; the ACJ 25.773(b)(1)(ii) should be eliminated.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [redacted]

The new FAR/JAR ruling clearly defines design and compliance criteria for pilot visibility through flight deck transparencies in one rule without relying on separate documents. It incorporates the more stringent of the existing FAA/JAA rules, and the harmonized rule merges existing proven requirements and industry standards which have resulted in safe aircraft systems with proven service experience.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [redacted]

The level of safety will be improved for those airplane systems and equipment previously certified only to the requirements of the FAA. System failure conditions and requirements to address loss of both windshield wipers have been incorporated by harmonization of the FAR and JAR rules to increase the level of safety by eliminating the potential for a single wiper switch failure leading to the loss of pilot visibility through both flight deck windshields.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [redacted]

The proposed standard maintains the same level of safety relative to current industry practice on newly certified aircraft which have two separate and independent windshield wiper switches, and would therefore be in compliance with the proposed standard.

10 - What other options have been considered and why were they not selected?: [Explain [redacted] and why they were not selected (e.g., cost/benefit, impact on [redacted] of components, etc.)]

One option would be to adopt the JAA Notice of Proposed Amendment to JAR 25.773(b). The NPA, however, would only partially harmonize the JAR and FAR requirements by deleting JAR 25.773(b)(4) and making other minor wording changes. It would also introduced a new Advisory Circular Joint 25.773(b)(3)(ii) which is more confusing than the proposed harmonization herein and does not improve safety. The NPA was circulated for comments within the JAA and is now on hold pending the outcome of this ARAC working group effort. It is recommended that the proposed NPA be superseded by the proposed harmonized FAR/JAR standard presented herein.

The only other option would be to harmonize the FAR and JAR by adopting the less stringent FAR and compromise the enhanced safety inherent in the JAR; therefore, this option was rejected. Simplification would be an option, by eliminating the AC as well as the ACJ, but the AC does add important criteria for defining sufficient pilot visibility. The AC also contains guidance material that is relevant to three other FARs; therefore, it should be retained with no revision.

11 - Who would be affected by the proposed change? [redacted]

Airplane manufacturers and suppliers will benefit from the single well-defined harmonized ruling reducing certification costs. Airplane manufacturers will need to design for two separate and independent windshield wiper switches. Airline operators may be negatively impacted from the standpoint of flight deck and crew interface commonality if they operate mixed fleets of previously certified aircraft with a single wiper switch activating both wipers, but will benefit from the enhanced safety inherent in the proposed standard.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [redacted]

In terms of advisory material relative to the FAR and JAR standards, the FAA AC 25.773-1 provides extensive definition of what constitutes sufficient pilot visibility through the windshield; therefore, it should be retained but does not need to be revised for harmonization of FAR/JAR 25.773(b). The JAR does not have equivalent advisory material. The AC also includes suggested means of compliance for windshield wiper speed. The ACJ 25.773(b)(1)(ii), however, includes suggested means of compliance for window heat system performance, which is not covered in the AC, but as previously discussed, the ACJ is not necessarily more stringent than the JAR reference to Appendix C and should therefore be eliminated in the harmonized standard.

Additionally, the preamble should include the following:

PREAMBLE

SUMMARY: This notice proposes to revise the requirements for pilot compartment view in precipitation conditions. This action is in response to the Aviation Rulemaking Advisory Committee (ARAC) Mechanical Systems Harmonization Working Group recommendation to harmonize paragraphs 25.773(b) of the Joint Aviation Requirements (JAR) with part 25.773(b) of the Federal Aviation Regulations (FAR).

BACKGROUND

On November 26, 1999 the FAA issued in the Federal Register a Notice of a new task to harmonize §25.773(b) with JAR Paragraph 25.773(b). The notice was issued to inform the public that the FAA has asked ARAC to provide advice and recommendations on harmonization of the FAA regulations and JAA requirements for pilot compartment view in precipitation conditions. This Notice of Proposed Rulemaking proposes a new pilot compartment view rule that has been harmonized to satisfy both the FAA and JAA.

General Discussion:

The intent of this rule is to combine the requirements of section 25.773(b) of the Federal Aviation Regulations (FAR), and paragraph 25.773(b) of the Joint Aviation Requirements (JAR), and the advisory material for paragraphs 25.773(b) of the JAR into one rule. The rule format is similar to the existing material for JAR 25.773(b).
This rule applies to flight deck ice and rain protection systems, specifically flight deck window heat and windshield rain removal systems and their elements.

For the purpose of this rule-
-the flight deck window heat system elements include the front windshields and side windows, electrical control components and the associated wiring and flight deck switches.
-the windshield rain removal system elements include the front windshield wipers, pneumatic air diffuser "jet blast" components, windshield chemical repellent coatings or dispensing components, electrical control components and the associated wiring and flight deck switches.

This rule has been changed to harmonize and clarify FAR 25.773(b) and JAR 25.773(b). The current version of paragraph 25. 773(b) of the JAR is more stringent than §25. 773(b) of the FAR by requiring provisions for rain removal during potential system failure conditions. The proposed changes in the rule reflect current airplane manufacturer design practices for some commercial transport models where current designs are already intended to meet the JAR 25.773(b); however, all models not currently certified by the JAA would be affected by the rule harmonization. The AC 25.773-1 provides guidance material defining sufficient pilot visibility through the windshield and will be retained

with no revisions. The ACJ 25.773(b)(1)(ii) does not impose any further restrictions beyond what is already considered in current airplane manufacturing design practices. Harmonization of FAR 25.773(b) and JAR 25.773(b) is not affected by the proposed removal of ACJ 25.773(b)(1)(ii).

Proposed Rule Discussion:

Paragraph (b)(1)(i) of the proposed, harmonized rule is written to define the applicable requirements for rain removal systems to provide adequate pilot visibility through the flight deck windshields. The rule defines the worst-case airplane flight condition and environmental precipitation conditions which must be considered when demonstrating compliance with the requirement.

Paragraph (b)(1)(ii) of the proposed, harmonized rule is written to define the applicable requirements for window heat (i.e. anti-icing) systems to provide adequate visibility through the flight deck windshields. The rule does not specifically address the airplane flight or environmental precipitation conditions which must be considered when demonstrating compliance with the requirement. Instead, the rule refers to FAR/JAR 25.1419, which provides definition of the icing environment (through further cross-reference to FAR/JAR 25 Appendix C continuous maximum and intermittent maximum icing envelopes). Therefore, the specific design parameters to be considered in showing compliance with Paragraph (b)(1)(ii) must be sufficiently adequate to meet to FAR/JAR 25.1419.

Paragraph (b)(2) of the proposed, harmonized rule is written to define the applicable redundancy requirements for rain removal systems. Specifically, this paragraph ensures that the design must have adequate redundancy such that system failures may not cause loss of adequate pilot visibility through the flight deck windshields. The primary implication of this requirement is that windshield wiper (or other mechanical means of rain removal) systems must have separate and independent control switches.

Paragraph (b)(3) of the proposed, harmonized rule is written to define the applicable requirements for openable flight deck side windows which must not only be openable, but must also meet the requirements for adequate visibility in the precipitation (i.e. rain) conditions of (b)(1). In addition, the visibility through the openable side windows must account for "sufficient protection from the elements", which should be interpreted to mean fog on the internal surface of the window. Additionally, ice protection should be considered, unless it is shown that the side window is not subject to external icing.

Paragraph (b)(4) of the proposed, harmonized rule is written to define the applicable requirements for alternative means of compliance with the requirement in Paragraph (b)(3) for openable flight deck side windows. Specifically, openable side windows may not be required if adequate flight deck window visibility can still be demonstrated even in the event of failures classified as more probable than Extremely Improbable, and also including encounters with severe hail, birds or insects.

Extremely Improbable is defined by the probability of a system failure which would have a catastrophic effect, thereby endangering the continued safe flight and landing of the aircraft by causing loss of life or loss of the aircraft.

The AC 25.773-1 does not specifically deal with compliance to the proposed rule, other than a suggested means of compliance with windshield wiper performance; nevertheless, it does provide guidance on sufficient pilot visibility through the windshield, and should be considered when demonstrating compliance with the proposed, harmonized rule.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [redacted]

As previously mentioned, AC 25.773-1 will be retained with no revisions for the harmonized ruling. ACJ 25.773(b)(1)(ii) will be eliminated.

14 - How does the proposed standard compare to the current ICAO standard? [redacted]

Due to their commitments as ICAO members, the US and all JAA-countries converted ICAO requirements into their airworthiness codes. So both the JAR and FAR 25 at least fulfill the ICAO minimum standards. As the proposed standard does not decrease the level of safety of FAR or JAR25, it is in line with ICAO Annex 8 "Airworthiness of Aircraft".

15 - Does the proposed standard affect other HWG's? [redacted]

Yes; the Ice Protection Harmonization Working Group may have to review the proposed harmonized standard.

16 - What is the cost impact of complying with the proposed standard? [redacted]

The proposed new standard will reduce the overall cost and time of the joint certification process. Most current aircraft designs accommodate the JAR, which is currently more stringent than the FAR. The primary in design cost would typically be the installation of a second windshield wiper switch. An increase in certification costs may result to those manufactures applying only for FAA type certificate since they would typically not need

to install a second wiper switch; but this is a minimal cost driver if the system is initially designed to comply with the proposed new standard. These costs are not considered significant.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain.

The "Fast Track" process is appropriate.

ARAC WG Report Format
Category 1 Items

1 - What is underlying safety issue addressed by the FAR/JAR? [redacted]

This requirement establishes the minimum design standard for trim indication systems. The intent of this standard is to provide accurate direction and position indication in relation to the airplane motion to the flight crew when the trim system is in operation.

2 - What are the current FAR and JAR standards? [redacted]

Current FAR text:
§ 25.677 Trim Systems.

(b) There must be means adjacent to the trim control to indicate the direction of the control movement relative to the airplane motion. In addition, there must be clearly visible means to indicate the position of the trim device with respect to the range of adjustment.

Current JAR text:

JAR 25.677 Trim Systems.

(b) There must be means adjacent to the trim control to indicate the direction of the control movement relative to the aeroplane motion. In addition, there must be clearly visible means to indicate the position of the trim device with respect to the range of adjustment. The indicator must be clearly marked with the range within which it has been demonstrated that take-off is safe for all centre of gravity position approved for take-off.

3 - What are the differences in the standards and what do these differences result in?: [redacted]

JAR 25.677(b) added a requirement to clearly mark a range on the trim indication system where take-off is safe for all center of gravity positions.

4 - What, if any, are the differences in the means of compliance? [redacted]

The applicant must mark safe take-off limits on the trim indication system.

5 – What is the proposed action? [redacted]

Adopt the JAR text in the Code of Federal Regulations 14 Part 25 Section 25.677(b). The JAR text will be added to the FAR text. trim indication system limits for all center of gravity positions where it is shown to be safe for take-off will be added to FAR 25. 677(b).

6 - What should the harmonized standard be? [redacted]

§ 25.677 Trim Systems.

(b) There must be means adjacent to the trim control to indicate the direction of the control movement relative to the airplane motion. In addition, there must be clearly visible means to indicate the position of the trim device with respect to the range of adjustment. The indicator must be clearly marked with the range within which it has been demonstrated that take-off is safe for all center of gravity position approved for take-off.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [redacted]

The proposed standard still addresses the safety issue in item #1. The proposed changes will be changed from the current rule by adding a new requirement that will effectively be a new minimum standard.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [redacted]

The proposed standard will increase the level of safety by adding a new requirement to mark safe take-off limits on the trim indication system.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [redacted]

The proposed standard will maintain the same level of safety as current industry practice. Most airplanes certified under current requirements already mark safe take-off limits on trim indication systems to show compliance to JAR 25.677.

10 - What other options have been considered and why were they not selected?: [redacted]

This is a simple change to the current standard. The change will harmonize Section 25.677 of the FAR with JAR 25.677. No other option was considered because of the simple change to the rule.

11 - Who would be affected by the proposed change? [redacted]

New Type Certificate Applicants.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [redacted]

No Advisory material exists for this rule. New advisory material is not proposed for this rule.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [redacted]

New advisory material is not proposed for this rule.

14 - How does the proposed standard compare to the current ICAO standard? [redacted]

No ICAO standard exists for "Trim Systems".

15 - Does the proposed standard affect other HWG's? [redacted]

The proposed rule for 25.677 does not affect other HWGs.

16 - What is the cost impact of complying with the proposed standard? [redacted]

The proposed change will not increase manufacturing or operation costs.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

The MSHWG requests to review the draft NPRM at "Phase 4" prior to publication in the Federal Register.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain.

This is a good candidate for the "FAST TRACK" process because the proposed change is not a controversial or complex change to the regulations.

Recommendation Letter

- 200

400 Main Street
East Hartford, Connecticut 06108

Pratt & Whitney
A United Technologies Company

June 1, 2000

Department of Transportation
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Attention: ✓Mr. Anthony Fazio, ARM-1

Subject: ARAC Report Submittal

Reference: ARAC Tasking, Federal Register, November 19, 1999

Dear Tony,

In accordance with the reference tasking, the ARAC Transport Airplane and Engine Issues Group is pleased to submit the following "Fast Track" reports as ARAC recommendations.

- 25.773 Pilot Compartment View ANM-00-085-A TASK #2
- 25.677 Trim Systems "

These reports have been prepared by the Mechanical Systems Harmonization Working Group of TAEIG.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant C[redacted]

Copy: Kri[redacted]-FAA-NWR
*Effie [redacted]-FAA-ARM-209
*P. Waters - Boeing

*letter only

CRB001_060100

Recommendation

Draft Version dated May 11, 2001

ARAC WG Report Format
Category 3 Items

1 - What is underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why does the requirement exist?]

In order to prevent unsafe conditions from developing due to an on-board fire, or to the use of built-in systems intended to combat them, FAR/JAR 25.851(b) requires that built-in fire extinguishers be installed so as to be non-hazardous to airplane occupants who are likely to be exposed to them, that the discharge of the extinguisher not cause structural damage, and that the capacity of the systems be adequate for any fire likely to occur in the designated compartment. Adequacy of the capacity of the "built-in system" is understood to mean that there is sufficient quantity of agent to combat the fire anywhere where baggage and cargo is placed within the cargo compartment for the time duration required to land and evacuate the airplane. Testing at the FAA Technical Center and other data from standardized fire extinguishing evaluation tests indicate that previously accepted means of compliance may not substantiate adequate concentration levels.

2 - What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]

Current FAR text: (Amendment 25-74, "Airplane Cabin Fire Protection", published in the Federal Register, 56 FR 15450, April 16, 1991)

(b) *Built-in fire extinguishers.* If a built-in fire extinguisher is provided-

(1) Each built-in fire extinguishing system must be installed so that-

(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur in the compartment where used, considering the volume of the compartment and the ventilation rate.

Current JAR text: (Change 14, May 27, 1994)

(b) *Built-in fire extinguishers.* If a built-in fire extinguisher is provided-

(1) Each built-in fire extinguishing system must be installed so that-

(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur in the compartment where used, considering the volume of the compartment and the ventilation rate.

3 - What are the differences in the standards and what do these differences result in?: [Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

There are no differences in the written standards. There are no harmonization issues related to section (b)(1).
The remainder of this report will only address the harmonization issues related to the application of section (b)(2) to cargo compartments with built in fire extinguishing systems.

4 - What, if any, are the differences in the means of compliance? [Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

Section 25.851(b) is intended to ensure that the built-in fire extinguishing system does not introduce a hazard to occupants or the airplane structure, and that the system is adequate to control any fire likely to occur. The ambiguity present has resulted in differing interpretations of the intent of

"... capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur in the compartment where used, considering ..."

which has resulted in different compliance test success criteria being imposed on applicants for FAR certification as opposed to JAR certification.

Most Transport Category airplane cargo compartment fire extinguishing systems utilize Halon 1301 as an extinguishing agent. This agent is stored as a liquid in pressurized containers, but is dispersed in the compartment when needed as a dense gas. Laboratory tests conducted by the FAA Technical Center in Atlantic City, New Jersey (Reference FAA-RD-71-68, November 1971) concluded that a three to five percent by volume concentration of Halon 1301 in combination with ventilation shutoff can effectively control cargo fires in Class C compartments. Since that time the consensus of U.S. and European airplane manufacturers, the FAA and JAA has been that to show compliance with the subject FAR and JAR, Halon cargo fire extinguisher systems must demonstrate the capability to provide an initial concentration of 5% by volume in an empty compartment, and maintain a 3% by volume concentration for the time period specified for the airplane's operational requirements.

In summary, it may be stated that FAA and JAA and applicants have adopted a two step method to certify Halon 1301 cargo fire suppression systems. First an initial use of Halon 1301 is provided at a concentration of five percent by volume in order to knock down a cargo fire. Subsequently, a second discharge via either a metered or discrete system is used to ensure that subsequent concentration levels should not drop below three percent by volume for the remainder of the flight in order to suppress a cargo fire until it can be completely extinguished by ground personnel following a safe landing. However, in demonstrating compliance to FAR/JAR 25.851(b) using this approach the FAA and JAA have utilized different methods of evaluating the concentration data.

Historically the FAA policy has accepted the use of a volumetric averaging of sensor data to show compliance. The FAA has also accepted in the past the use of CO_2 decay tests to determine the cargo compartment leakage in flight, with the Halon concentration determined analytically. This also resulted in approval of an average value for Halon concentration. Current JAA policy does not accept averaging methods but requires that each individual sensor display the required concentration. Compliance with this standard has been required by Certification Review Item in some recent JAR validation programs. Testing at the FAA Technical Center and other data from standardized fire extinguishing evaluation tests indicates that the use of averaging techniques may not substantiate that there are adequate concentration levels of fire extinguishing agent throughout the compartment to effectively suppress a cargo fire. If a cargo fire occurred, and was subsequently suppressed by Halon 1301, the core of the fire could remain hot for a period of time. If the local concentration of Halon 1301 in the vicinity of the fire core dropped below three percent by volume and sufficient oxygen is available, reignition could occur. FAA testing has shown that when the Halon 1301 concentration level drops below three percent by volume and the cargo fire reignites, the convective stirring caused by the heat of the fire may be insufficient to raise the local concentration of Halon 1301 in the vicinity of the fire. As a result of this finding, the FAA philosophy began to change in the mid-1990's and in letters (Reference 97-111-68, September 1997) to manufacturers expressed concern, i.e., "*This averaging technique may allow the concentration level to drop below three percent by volume of individual sampling locations near the top of the cargo compartment while maintaining an average concentration level of three percent by volume throughout the cargo compartment.*" Furthermore, in a Memorandum from the Transport Standards Staff to all Transport Airplane Aircraft Certification Offices (Reference 97-113-143, dated October 1997) recommended that Aircraft Certification Offices "*advise your applicants that the use of the technique of volumetric averaging to determine the minimum Halon 1301 concentration is questionable in light of the testing accomplished by the FAA's Technical Center.*" This concern was based upon testing conducted at the FAA's William J. Hughes Technical Center (Reference DOT/FAA/AR-96/5, June 1996) which indicated that the volumetric averaging method may not provide adequate concentration levels of fire extinguishing agent to effectively suppress a cargo fire in all areas of the cargo compartment.

5 – What is the proposed action? [Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

The proposed action is to release joint FAR/JAR changes and advisory material (FAA Advisory Circular and JAA Advisory Circular – Joint) which document acceptable methods for conducting flight tests and/or analyses which can be used for showing compliance to both FAR and JAR 25.851(b)(2).

It is understood that in order for the FAA to accommodate a more restrictive means of compliance this interpretation and intent must be introduced either in the actual text of the FAR or into the preamble of the FAR itself. Thus the FAA has proposed the indicated change in the FAR and creation of associated advisory material.

The advisory material should preclude the use of averaging techniques in compliance demonstrations for FAR/JAR 25.851(b)(2). The advisory material will define in general terms where gaseous extinguishing agent concentrations should be measured, and how the discrete measured data should be interpreted. There is no current plan to investigate the suitability of the 5% initial and 3% sustained concentration limits. The advisory material will also establish criteria for evaluating brief excursions in the concentration readings and if the data from a single measuring point can be time-averaged. Additional laboratory testing is recommended only if critical issues requiring advisory clarification cannot be resolved by other means.

6 - What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

It is recommended that the following text be adopted to FAR/JAR 25.851(b).

> *(b) Built-in fire extinguishers. If a built-in fire extinguisher is provided-*
>
> *(1) Each built-in fire extinguisher system must be installed so that--*
>
> *(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and*
>
> *(ii) No discharge of the extinguisher can cause structural damage.*
>
> *(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur "**anywhere**" in the compartment where used, considering the volume of the compartment and the ventilation rate.*
>
> {Note to Technical Writer: The use of bold italics indicating *"anywhere"* above was intended only to highlight the change and was not intended for the final rule.}

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

The resulting FAR/JAR change will enable the FAA to accept the harmonized position and promote the harmonized means of compliance. Attached to this report is material that should be incorporated into the preamble of the FAR/JAR change. This material provides background and the intent of the proposed change.

The resulting Advisory Material will define an acceptable test and analysis method that will allow applicants to demonstrate how their proposed systems meet these minimum standards. This will prevent the approval of systems that might not maintain adequate extinguishing capability for the predicted fire threat. Further guidance is given to ensure fire extinguishing/ suppression system effectivity during operation.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The proposed rule change clarifies the basic intention of the rule as it specifies that a fire must be controllable "anywhere" in the compartment where it is likely to occur. This rule change became necessary after an FAA policy change prohibiting an previously accepted means of compliance, now requiring certain extinguishing agent concentration levels at all appropriate measurement points instead of allowing averaging methods. Relative to the current FAR, the proposed standard increases the level of safety as it avoids uncertainties in agent concentrations not detectable with previous methods.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

The proposed rule change clarifies the intention of the rule as it specifies that a fire must be controllable anywhere in the compartment where it is likely to occur. Major aircraft manufacturers practice did already consider this in design and compliance demonstration. Therefore the proposed standards maintains the level of safety achieved by current major industry practice. For TC or STC applicants inexperienced in large transport aircraft certification the rule is now more precise and a slight increase of level of safety may be expected.

Most new airplanes certified in the past two years have met the more stringent JAR compliance method. Those that have not were not required to do so by the certifying agency, but have demonstrated performance very close to the requirement. The proposed new guidance will, for the first time, provide specific guidance by defining the minimum

agent concentration allowable at any measured location and ensure that the intent of the FAR is met.

10 - What other options have been considered and why were they not selected?: [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]

A FAR/JAR change is required to enable the FAA to adopt the harmonized means of compliance. Any detailed compliance method developed in the near future would be specific to Halon 1301. This agent is scheduled for phase-out in the future, and other agents are under development. It would be inappropriate for this type of product specific detail to appear in the FARs and JARs. Creating a compliance standard based on existing test data and documented in advisory material is the most logical and cost-effective method of resolving this issue. Data available at this time indicates evidence that warrants the adoption of this change in compliance standards.

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Manufacturers, modification centers and system suppliers would bear additional costs to design, test and possibly redesign/re-test fire extinguishing systems. Operators would bear additional costs to carry the weight of the extra extinguishing agent and to maintain a more complex distribution system.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

The recommended Draft FAR/JAR change is attached. It contains accompanying preamble material that corroborates the selection of this harmonized approach. There is no existing advisory material on this subject.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

The existing FAA advisory material is not adequate. Current practices are based on precedents set in the 1970's, on certification plans negotiated for specific airplane projects by different Aircraft Certification Offices, and on various FAA policy memos and correspondence with Manufacturers. None of these sources adequately define a

requirement to maintain a certain agent concentration at discrete points in the cargo compartments.

Full-scale fire tests conducted over the years have used various methods to determine agent concentration, including analysis, discrete point measurement and averaging of discrete measurements. The current 5% initial and 3% sustained concentration standards are believed to derive from the FAA Technical Center test report FAA-RD-71-68 referenced above. Since the test report shows no Halon measuring instrumentation, it is assumed the Halon concentration was calculated based on measurements of the amount of Halon discharged and the compartment volume. This can only provide a volumetric average concentration value. This is believed to be the origin of the practice of finding compliance using the averaging technique.

The JAA policy has been documented in recent Certification Review Items on specific airplane programs. The JAA has typically accepted the traditional location of agent concentration measuring points. The JAA currently requires that all of the sensors indicate a concentration at or above 5% initial and 3% sustained. These agreements are typically documented in the system certification plans and related correspondence.

The harmonized method of compliance should define in general terms where gaseous extinguishing agent concentrations should be measured, and what the minimum concentration should be. Methods for certifying agent concentrations with loaded compartments should also be provided. Methods for evaluating data anomalies, effect of airplane maneuvering on test data, proposals for time averaging data at discrete points, and brief excursions below the required lower limits should also be provided.

14 - How does the proposed standard compare to the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

Due to their commitments as ICAO members, the US and all JAA-countries converted ICAO requirements into their airworthiness codes. So both the JAR and FAR 25 at least fulfill the ICAO minimum standards. As the proposed harmonized rule and compliance method does not decrease the current level of safety of FAR or JAR 25, it is in line with ICAO Annex 8 "Airworthiness of Aircraft".

15 - Does the proposed standard affect other HWG's? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]

No other HWG's are affected by this proposed rule change and compliance method harmonization.

16 - What is the cost impact of complying with the proposed standard? [Please provide information that will assist in estimating the change in cost (either positive or negative) of the proposed rule. For example, if new tests or designs are required, what is known with respect to the testing or engineering costs? If new equipment is required, what can be reported relative to purchase, installation, and maintenance costs? In contrast, if the proposed rule relieves industry of testing or other costs, please provide any known estimate of costs.]

The proposed new compliance method will reduce the overall cost and time of the joint certification process. Most current aircraft designs accommodate the JAR compliance method, which is currently more stringent than the FAR Therefore the additional costs for new type design certification should be minimal. Only type design previously planned to be certified under FAR only, supplemental and amended type designs may have to include additional agent or more complex distribution systems to be able to show compliance.

FAR/JAR 25.851(b)(2) requires certification of extinguishing agent dissipation rates by flight test. Since gaseous extinguishing systems typically can only be flight tested after the first airplane installation is completed due to the effects of compartment leakage, the costs of meeting the more stringent point concentration standard may be significant if the design must be changed and re-tested at the end of a development program. These last-minute changes are costly for all projects, whether for New, Amended or Supplemental type designs.

17. - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

The Draft Advisory Circular contains the proposed harmonized method of compliance with the provisions of 14 CFR Part 25 §§ 25.851, 25.855 and 25.857 of the Federal Aviation Regulations (FAR) related to the built-in fire suppression systems when required for cargo compartments for transport category airplanes. This material provides definitions of the applicable cargo compartments, locations where gaseous extinguishing agent concentrations should be measured, and what the minimum concentration should be at different locations within the compartment. Methods for certifying agent concentrations with loaded compartments, for evaluating data anomalies, for the effect of airplane maneuvering on test data and brief excursions below the required lower limits are provided. Further guidance is given to ensure fire extinguishing/suppression system effectivity during operation by making the involved personnel aware of loading restrictions.

18 -Does the HWG want to review the draft Notice of Proposed Rulemaking prior to publication in the Federal Register?

A Notice is required for the proposed FAR change and the working group would like to review any draft Notice of Proposed Rulemaking prior to publication in the Federal Register.

No Notice is required for the advisory material. However, it has been the policy of the Transport Airplane Directorate to provide a Notice of Availability of Proposed Advisory Circular (AC) and request for comments prior to issuing advisory material. Therefore, the HWG would like to review any draft notice prior to publication in the Federal Register.

19 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]

This project is recommended for the Fast Track process as it is believed that sufficient corroborating test material is currently available. FAA had a draft AC prepared which incorporated some of the intended guidance. That draft was edited and additional material added to expand the content to include guidance on alternate Halon gaseous agents, alternate liquid fire extinguishing/suppression systems, gaseous simulants, procedures which must be included in applicable manuals and associated cargo compartment placards and markings.

The HWG considered this recommendation still valid although a rule change was necessary following the prohibition of a previously FAA-accepted certification testing policy in the draft AC. As this new policy basically took over methods already requested during JAA certifications, but not explicitly expressed in current rules or up to date advisory material, no significant regulatory difference was created. Therefore it was necessary to re-classify this harmonization task from "better Plan of Harmonization-Category 1 to Category 3, but it stays within the ARAC Fast-Track-Approach framework.

#2

ARAC WG Report Format
FAR/JAR 25.729 Retracting Mechanism

1 - What is underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why does the requirement exist?]

23004

This FAR/JAR contains minimum design and certification requirements for airplanes with retractable landing gear. The requirements address:

(a) Loads imposed during flight on the landing gear structure and mechanism,
(b) Positive locking of the kinematic mechanisms,
(c) Redundant means of extending the landing gear,
(d) Demonstration of proper operation by test,
(e) Means of informing the pilot(s) of the landing gear position and lock status,
(f) Equipment damage from tire burst, loose tread, and wheel brake temperatures.

The underlying safety issue is that a retractable landing gear introduces new airplane configurations not found on airplanes with fixed landing gear. The gear up configuration improves climb and cruise performance. The gear down configuration will increase drag and fuel burn and usually has speed limitations due to air loads. Failure of the landing gear to extend for landing exposes the flight crew and passengers to the risk of injury and results in economic damage. A typical flight plan is based in part on appropriate landing gear configurations at the appropriate times. The regulations serve to ensure that the landing gear is in the appropriate or at least most critical configuration when necessary, that the landing gear operates properly, that the flight crew is aware of the landing gear position status, and that the critical systems are retained in the event of tire related failure conditions.

2 - What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]

Current FAR Text

14 Code of Federal Regulations (CFR) 25.729

§ 25.729 Retracting Mechanism.

(a) *General.* For airplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for-

(i) The loads occurring in the flight conditions when the gear is in the retracted position,

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_s (with the flaps in takeoff position at design takeoff weight), occurring during retraction

and extension at any airspeed up to 1.6 V_{s1} (with the flaps in the approach position at design landing weight), and

(iii) Any load factor up to those specified in §25.345(a) for the flaps extended condition.

(2) Unless there are other means to decelerate the airplane in flight at this speed, the landing gear, the retracting mechanism, and the airplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_c.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing maneuvers prescribed for the airplane in addition to the conditions of airspeed and load factor prescribed in paragraphs (a)(1) and (2) of this section.

(b) *Landing gear lock.* There must be positive means to keep the landing gear extended, in flight and on the ground.

(c) *Emergency operation.* There must be an emergency means for extending the landing gear in the event of-

(1) Any reasonably probable failure in the normal retraction system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator and warning device.* If a retractable landing gear is used, there must be a landing gear position indicator (as well as necessary switches to actuate the indicator) or other means to inform the pilot that the gear is secured in the extended (or retracted) position. This means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by paragraph (e)(2) of this section such that it could be operated instinctively, inadvertently, or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to eliminate false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(f) *Protection of equipment in wheel wells.* Equipment that is essential to safe operation of the airplane and that is located in wheel wells must be protected from the damaging effects of-

(1) A bursting tire, unless it is shown that a tire cannot burst from overheat; and

(2) A loose tire tread, unless it is shown that a loose tire tread cannot cause damage.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-23, 35 FR 5676, Apr. 8, 1970; Amdt. 25-42, 43 FR 2323, Jan. 16, 1978;
Amdt. 25-72, 55 FR 29777, July 20, 1990; Amdt. 25-75, 56 FR 63762, Dec. 5, 1991]

Current JAR Text

JAR 25.729 Retracting mechanism

(a) *General*. For aeroplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for--

(i) The loads occurring in the flight conditions when the gear is in the retracted position;

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_s (with the flaps in take-off position at design take-off weight), occurring during retraction and extension at any airspeed up to 1.6 V_{s1} with the wing-flaps in the approach position at design landing weight, and

(iii) Any load factor up to those specified in JAR 25.345 (a) for the wing-flaps extended condition.

(2) Unless there are other means to decelerate the aeroplane in flight at this speed, the landing gear, the retracting mechanism, and the aeroplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_c.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing manoeuvres prescribed for the aeroplane in addition to the conditions of airspeed and load factor presented in sub-paragraphs (a)(1) and (2) of this paragraph.

(b) *Landing gear lock*. There must be positive means to keep the landing gear extended in flight and on the ground. <u>There must be positive means to keep the landing gear and doors in the correct retracted position in flight, unless it can be shown that lowering of the landing gear or doors, or flight with the landing gear or doors extended, at any speed, is not hazardous</u>.

(c) *Emergency operation*. There must be an emergency means for extending the landing gear in the event of--

(1) Any reasonably probable failure in the normal action system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test*. The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator and warning device.* (See ACJ 25.729 (e). If a retractable landing gear is used, there must be a landing gear position indicator easily visible to the pilot or to the appropriate crew members (as well as necessary devices to actuate the indicator) to indicate without ambiguity that the retractable units and their associated doors are secured in the extended (or retracted) position. The means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by sub-paragraph (e)(2) of this paragraph such that it could be operated instinctively, inadvertently or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to minimise false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(7) A clear indication or warning must be provided whenever the landing gear position is not consistent with the landing gear selector lever position.

(f) *Protection of equipment on landing gear and in wheel wells.* Equipment that is essential to the safe operation of the aeroplane and that is located on the landing gear and in wheel wells must be protected from the damaging effects of--

(1) A bursting tyre, (see ACJ 25.729 (f);

(2) A loose tyre tread unless it is shown that a loose tyre tread cannot cause damage; and

(3) Possible wheel brake temperatures, (see ACJ 25.729 (f).

Ch. 14 (Amend. 93/1, Eff. 8.3.93)

ACJ 25.729(e) - Retracting Mechanism (Interpretative Material)

See JAR 25.729(e)

1 When light indicators are used, they should be arranged so that-

(a) A green light for each unit is illuminated only when the unit is secured in the correct landing position.

(b) A warning light consistent with JAR 25.1322 is illuminated at all times except when the landing gear and its doors are secured in the landing or retracted position.

2 The warning required by JAR 25.729(e)(2) should preferably operate whatever the position of wing leading- or trailing-edge devices or the number of engines operating.

3 The design should be such that nuisance activation of the warning is minimised, for example-

a. When the landing gear is retracted after a take-off following an engine failure, or during a take-off when a common flap setting is used for take-off and landing;

b. When the throttles are closed in a normal descent; or

c. When flying at low altitude in clean or low speed configuration (special operation).

4 Inhibition of the warning above a safe altitude out of final approach phase either automatically or by some other means to prevent these situations is acceptable, but it should automatically reset for a further approach.

5 Means to de-activate the warning required by JAR 25.729(e) may be installed for use in abnormal or emergency conditions provided that it is not readily available to the flight crew, i.e. the control device is protected against inadvertent actuation by the flight crew and its de-activated state is obvious to the flight crew.

Ch. 14 (Amend. 93/1, Eff. 8.3.93)

ACJ 25.729(f) - Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance)

See JAR 25.729(f)

The use of fusible plugs in the wheels is not a complete safeguard against damage due to tyre explosion.

Where brake overheating could be damaging to the structure of, or equipment in, the wheel wells, an indication of brake temperature should be provided to warn the pilot.

Ch. 14 (Amend. 93/1, Eff. 8.3.93)

3 - What are the differences in the standards and what do these differences result in?: [Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

Paragraph 25.729...	Description	Difference and result
(b)	Landing gear lock	The JAR additionally requires a positive means to keep the landing gear and doors in the correct retracted position unless extending the gear and doors at any flight speed is not hazardous. This results in the need for uplock mechanisms that will function in the event that the primary retraction energy is lost, or in robust gear and door mechanisms that can withstand deployment at any flight speed. The requirement is not overly stringent since loss of primary retraction energy is an expected event. The uplock mechanism is preferred since extension of the landing gear will increase fuel consumption due to increased drag.
(e)	Position indicator and warning device	The JAR refers to ACJ 25.729(e). The JAR further refines the definition of the indicator to: 1. be easily visible to the pilot or appropriate crew members, 2. indicate without ambiguity the position of the gear. In addition the JAR requires that the indicator also provide similar position information about the associated landing gear doors. These additions simply state what should be intrinsic to any prudent landing gear indication design.

(e)(5)		Regarding false or inappropriate alerts, the FAR uses the word "eliminate" while the JAR uses the more practical word "minimise." If taken literally, the FAR requirement is overly stringent. While elimination of nuisance warnings is a worthy goal, it is virtually impossible to actually never have a nuisance warning unless the system is unable to provide any warning. The JAR requirement is more subjective but attainable and embraces any improvements in warning system technology.
(e)(7)		The FAR does not contain this subparagraph. The subparagraph requires an indication if the landing gear position does not agree with the selector lever position. This is consistent with prudent landing gear indication design.
(f)	Protection of equipment from rolling stock threats	In addition to protection of equipment in the wheel well, the JAR includes protection of equipment on the landing gear. This results in analysis and protection of equipment that is not just in the wheel well but also on the landing gear either gear retracted or extended. This is reasonable since equipment on the lower part of the landing gear is always near the tire and therefore should be considered.
(f)(1)	Tire burst, loose tread	The JAR deletes the FAR condition ", unless it is shown that a tire cannot burst from overheat;" and refers to ACJ 25.729(f) which states that wheel fuse plugs are not a complete means of compliance to protection of essential equipment from tire burst. This results in removal of two possible, however not very viable, compliance methods i.e. showing the tire will not burst from overheat or the use of wheel fuse plugs.
(f)(3)	Brake temp.	The FAR does not contain this subparagraph. The JAR requires protection of equipment from possible wheel brake temperatures and refers to ACJ 25.729(f) which suggests an indication of brake temperature should be provided to the pilot. This results in an analysis of equipment that could be exposed to heat from the brake or installation of a brake heat indication system. With regard to safety and cost, locating essential equipment away from possible brake heat is superior to an additional indication system which has its own failure mode and maintenance issues.

4 - What, if any, are the differences in the means of compliance? [Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

If taken literally, each regulatory difference identified in 3 above involves a different means of compliance. Typically the JAR has additional requirements that would involve additional means of compliance. These literal differences are:

Paragraph 25.729…	Literal compliance difference
(b)	The JAA is more stringent requiring each retractable landing gear and separately actuated door to have a positive uplock or, be able to extend or open into the air stream at any flight speed without causing a hazard. Compliance would be demonstrated by system description or stress analysis.
(e)	For the JAA each indicator must be visible to the appropriate crew members and not be ambiguous regarding gear position. The JAA requirement is somewhat redundant since an indicator that is not visible or is ambiguous would not perform its intended function per 25.1301. The JAA is more stringent requiring the indicator to also indicate associated landing gear door position. Strict compliance with either regulation would require an explicit UP (and for the JAR, Doors Closed) indication. Current "quiet, dark cockpit" philosophy displays gear down, gear disagree, and door open only but not gear up or doors closed. Compliance is demonstrated by system description and failure modes and effects analysis.
(e)(5)	The FAA is more stringent requiring the aural warning system to eliminate false or inappropriate alerts. Compliance is demonstrated by failure mode and effects analysis with an understanding that eliminate means "very low probability."
(e)(7)	The JAA is more stringent requiring an indicator if the landing gear position does not agree with the selector lever position. Compliance is demonstrated by system description and failure mode and effects analysis.
(f)(1)	The JAA is more stringent. The JAR omits the FAA condition which excludes consideration of tire burst if it can be shown that the tires will not burst from overheat, and the JAR refers to an ACJ which excludes wheel fuse plugs as a complete means of compliance. Note that the term "explosion" used in the ACJ is referring to tire burst and not an actual tire explosion caused by the combustion of oxygen and rubber hydrocarbons. Additional means of compliance such as separation analysis, robust design or test are required. (The FAA has taken the same position in letter WE-130, "Tire Burst Protection for Essential Equipment Located in Wheel Wells – 737 Airplane," C.R. Hanks to B.L. Carter, dated Nov. 14, 1966 and per AC 25-22 in an FAA memorandum dated Dec. 4, 1997.)
(f)(3)	The JAA is more stringent in requiring protection of essential equipment from the damaging effects of possible wheel brake temperatures.

	Compliance is demonstrated by separation analysis, thermal analysis, or, as suggested in the ACJ, a brake temperature indication system.

In addition to the regulatory differences described above, the FAA and JAA have different advisory material pertaining to 25.729 as follows:

FAA AC 25-22, Certification of Transport Airplane Mechanical Systems, dated March 14, 2000. Summaries of the relevant compliance methods are:

25.729(f)(1) The intent is to protect essential equipment from the effects of a tire burst regardless of the cause of the burst. The preamble to Amendment 25-78 refers to a tire burst as a sudden, sometimes violent, venting of the pressure from within a tire. With this in mind equipment in the wheel well is evaluated for its ability to withstand the effects of a bursting tire and design changes are often made to ensure that a single tire burst will not cause loss of critical functions.

25.729(e) This section is extracted from an FAA memorandum dated July 12, 1988, which addresses whether a backup gear position indication system is required. The section also contains portions of an FAA memorandum dated June 3, 1983, which addresses whether other regulations need to be considered when finding compliance to 25.729(e). (e.g. 25.1301 and 25.1309)

Landing Gear Slush Tests While not a specific regulation, this section is extracted from an FAA memorandum dated April 12, 1983, addressing the need for tests to ensure that the landing gear can be extended if joints should become frozen during the flight.

FAA AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes, dated June 3, 1999. Summaries of the relevant compliance methods are:

25.729(d) Flight tests should be conducted to demonstrate the ability of the landing gear and associated components, in their heaviest configuration to properly retract and extend in 1 g flight, normal yaw angles, and airspeeds up to V_{LO} Additionally an engine out gear retraction time demonstration procedure is described.

25.729(e) A combination of flight tests, ground tests, and analysis may be used to show compliance with the intent of 25.729(e)(2) through (e)(4).

JAA ACJ 25.729(e) Retracting Mechanism (Interpretive Material), discusses 1) the conditions for and color of light indicators, 2) aural warning with any high lift or engine configurations, 3) avoidance of nuisance activation, 4) inhibition of the warning at appropriate flight phases, 5) means for deactivation by the flight crew. In particular ACJ 25.729(e)(1)(b) recommends a warning light consistent with JAR 25.1322 ("warning" means a red light) be illuminated at all times except when the landing gear and its door are secured in the landing or retracted position.

JAA ACJ 25.729(f) protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance), discusses 1) exclusion of wheel fuse plugs as complete compliance method, 2) recommendation of a wheel brake temperature warning to the pilot.

Excluding 25.729(f), the actual Boeing experience is that there has been only two regulations where we have encountered difference in showing compliance between FAR 25.729(a) thru (e) and JAR 25.729(a) thru (e). One difference is the interpretation of 25.729(a)(1)(iii) where the FAA understands this to be a load consideration for structural integrity of mechanical elements and the JAA occasionally interprets this as a load condition under which the landing gear actuation system must operate. The other difference is JAR 25.729(e)(7) and ACJ 25.279(e)(1)(b) which suggest a red colored indication should be displayed whenever the landing gear are in transit. This is not an FAA requirement. It is not consistent that a normal landing gear retraction or extension illuminate a light that indicates "a hazard that may require immediate corrective action" per JAR 25.1322.

Regarding 25.729(f), there has been a significant difference in the means of compliance between the FAR and the JAR. Apart from the obvious wording differences and the additional requirement imposed by JAR 25.729(f)(3), since 1995 the JAA has imposed a Means of Compliance Certification Review Items (CRI) for JAR 25.729(f)(1) tire burst, and (f)(2) loose tread. The CRIs define specific interpretations of JAR 25.729(f)(1) and (2) and states that addressing the failure modes so defined would be an acceptable means to demonstrate compliance to the applicable airworthiness requirements. The defined failure modes are well beyond what has been acceptable for showing compliance to FAR 25.729(f). While the CRI is introduced as one acceptable means of compliance, Boeing efforts to introduce alternative failure models based on service experience and previous airplane certifications were strongly resisted because the JAA wanted to standardize compliance to JAR 25.729(f) with all manufacturers. Standard means of compliance is preferred by Boeing but it should have a basis in analysis and service experience.

5 – What is the proposed action? [Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

FAR/JAR 25.729(a) through (f) can be treated as Category 1 and basically enveloped. For the most part the additional requirements in the JARs simply emphasize what should be good design practice. Proposed advisory material was developed from the existing FAA AC and JAA ACJ material and is included under "6. Harmonized Standard".

Proposed Future Action.

As a separate future exercise the following items should be accomplished:

a. Modify 25.729(a)(1)(iii) to clarify that an explicit indication is not required to indicate landing gear up and doors closed.

b. Incorporate minor wording changes as proposed under "10. What other options..." of this report. These changes will clarify the intent of the regulation and avoid words that have specific meaning beyond the intent of the regulation.
c. Advisory material should be expanded to incorporate the intent of the JAA CRIs with some adjustments to allow for simpler analysis of tire and wheel threats.

This proposed future effort (a., b., and c.) should be treated as Category 3 since it is anticipated that significant negotiations will be required to accomplish this action.

6 - What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

25.729 Retracting mechanism

(a) *General.* For airplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for--

(i) The loads occurring in the flight conditions when the gear is in the retracted position;

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_s (with the flaps in take-off position at design take-off weight), occurring during retraction and extension at any airspeed up to 1.6 V_{s1} with the wing-flaps in the approach position at design landing weight, and

(iii) Any load factor up to those specified in § 25.345 (a) for the wing-flaps extended condition.

(2) Unless there are other means to decelerate the airplane in flight at this speed, the landing gear, the retracting mechanism, and the airplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_C.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing maneuvers prescribed for the airplane in addition to the conditions of airspeed and load factor presented in paragraphs (a)(1) and (2) of this section.

(b) *Landing gear lock.* There must be positive means to keep the landing gear extended in flight and on the ground. There must be positive means to keep the landing gear and doors in the correct retracted position in flight, unless it can be shown that lowering of the landing gear or doors, or flight with the landing gear or doors extended, at any speed, is not hazardous.

(c) *Emergencyoperation.* There must be an emergency means for extending the landing gear in the event of--

(1) Any reasonably probable failure in the normal actuation system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator and warning device.* If a retractable landing gear is used, there must be a landing gear position indicator easily visible to the pilot or to the appropriate crew members (as well as necessary devices to actuate the indicator) to indicate without ambiguity that the retractable units and their associated doors are secured in the extended (or retracted) position. The means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by paragraph (e)(2) of this section such that it could be operated instinctively, inadvertently or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to minimize false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(7) A clear indication or warning must be provided whenever the landing gear position is not consistent with the landing gear selector lever position.

(f) *Protection of equipment on landing gear and in wheel wells.* Equipment that is essential to the safe operation of the airplane and that is located on the landing gear and in wheel wells must be protected from the damaging effects of--

(1) A bursting tire;

(2) A loose tire tread, unless it is shown that a loose tire tread cannot cause damage; and

(3) Possible wheel brake temperatures.

AC 25.729-1X or ACJ 25.729–Transport Airplane Landing Gear Retracting Mechanisms (Interpretive Material)

(Example written as an AC for the FAA)

1. PURPOSE. This Advisory Circular (AC) provides guidance material for use as an acceptable means of demonstrating compliance with the landing gear retracting mechanism requirements of the Federal Aviation Regulations (FAR) for transport category airplanes. Like all AC material, this AC is not, in itself, mandatory and does not constitute a regulation. It is issued to provide an acceptable means, although not the only means, of compliance with the rules. Terms used in this AC, such as "shall" and "must," are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described herein is used. While these guidelines are not mandatory, they are derived from extensive Federal Aviation Administration and industry experience in determining compliance with the pertinent FAR. This advisory circular does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

2. RELATED DOCUMENTS

a. Related Federal Aviation Regulations. Section 25.729 of the FAR, as amended through Amendment 25-xx, and other sections relating to landing gear retracting mechanism installations. Sections which prescribe requirements for the design, substantiation, and certification of landing gear retracting mechanisms include:

§ 25.111	Takeoff path
§ 25.301	Loads
§ 25.303	Factor of safety
§ 25.305	Strength and deformation
§ 25.307	Proof of structure
§ 25.333	Flight envelope
§ 25.471	General [Ground loads]
§ 25.561	General [Emergency Landing Cond.]
§ 25.601	General [Design and Construction]
§ 25.603	Materials
§ 25.605	Fabrication methods
§ 25.607	Fasteners
§ 25.609	Protection of structure
§ 25.613	Material strength properties
§ 25.619	Special factors

§ 25.621	Casting factors
§ 25.623	Bearing factors
§ 25.625	Fitting factors
§ 25.729	Retracting mechanism
§ 25.777	Cockpit controls
§ 25.779	Motion and effect of cockpit controls
§ 25.781	Cockpit control knob shape
§ 25.863	Flammable fluid fire protection
§ 25.869	Fire protection: systems
§ 25X899	Electrical bonding, etc. (JAA only)
§ 25.1301	Function and installation.
§ 25.1309	Equipment, systems and installations.
§ 25X1315	Negative acceleration. (JAA only)
§ 25.1316	System lightning protection.
§ 25.1322	Warning, caution and advisory lights.
§ 25.1353	Electrical equipment and installations.
§ 25.1357	Circuit protective devices.
§ 25X1360	Precautions against injury. (JAA only)
§ 25.1435	Hydraulic systems.
§ 25.1515	Landing gear speeds.
§ 25.1555	Control markings.
§ 25.1583	Operating limitations.
§ 25.1585	Operating procedures.

b. Advisory Circulars (AC's).

AC 20-34D,	Prevention of Retractable Landing Gear Failures
AC 23.729-1,	Landing Gear Doors and Retraction Mechanism (For information only)
AC 25.1309-1A	System Design and Analysis
AC 25-7A	Flight Test Guide for Certification of Transport Category Airplanes
AC 25-22	Certification of Transport Airplane Mechanical Systems
AC 43.13-1A	Acceptable Methods, Techniques and Practices – Aircraft Inspection and Repair.

c. Federal Aviation Administration Orders.

Order 8110.4A	Type Certification Process

Advisory Circulars and FAA Orders can be obtained from the U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.

d. Society of Automotive Engineers (SAE) Documents.

SAE AIR-4566	Crashworthiness Landing Gear Design
SAE ARP-1311A	Landing Gear - Aircraft
ISO 7137	Environmental Conditions and Test Procedures for Airborne Equipment (not an SAE document but is available from the SAE)

These documents can be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania, 15096.

e. RTCA Documents.

RTCA/DO-160D	Conditions and Test Procedures for Airborne equipment, Issued July 12, 1996.
RTCA/DO-178B	Software Considerations in Airborne Systems and Equipment Certification, Issued December 1, 1992

Copies of RTCA documents may be purchased from the RTCA Inc., 1140 Connecticut Avenue NW, Suite 1020, Washington, D.C. 20036.

f. Military Documents.

MIL-STD-810	Environmental Test Methods and Engineering Guidelines

This document can be obtained from the Department of Defense, DODSSP, Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

3. BACKGROUND.

Effective February 1, 1965, Part 25 was added to the Federal Aviation Regulations (FAR) to replace Part 4b of the Civil Air Regulations (CAR). Sections 4b.334 and 4b.334-2 of the CAR, became §25.729 of the FAR for landing gear retracting mechanism.

(1) Amendment 25-23 (April 8, 1970) added a wheel rotational speed based on a factored takeoff speed of 1.3 to be used for load computations under § 25.729(a)(1)(ii) and changed the reference from § 25.345 to § 25.345(a) under § 25.729(a)(1)(iii).

(2) Amendment 25-42 (January 16, 1978) clarified the rule and made minor editorial changes to § 25.729(e)(3).

(3) Amendment 25-72 (July 20, 1990) amended the rule. It made editorial changes and deleted reference to § 25.67(e) under § 25.729(e)(4), since § 25.67 no longer existed.

(4) Amendment 25-75 (December 5, 1991) revised §25.729(e)(2) through (e)(6) to state objectives without stating how the requirements were to be met; thus allowing manufacturers to use their ingenuity in designing systems to minimize the occurrence of nuisance and inappropriate aural warnings.

(5) Amendment 25-XX (date) **[Insert amendment number and date when published]**, revised §25.729(a) through (f) to harmonize FAA Standards with JAA Standards for Transport Category Airplanes. The revision was accomplished by taking the envelope of the two requirements.

4. DISCUSSION

a. Intent of Rule. (Reference §25.729 Retracting mechanism) This rule provides minimum design and certification requirements for landing gear actuation systems to address:

(1) Structural integrity for the nose and main landing gear, retracting mechanism(s), doors, gear supporting structure for loads imposed during flight,
(2) Positive locking of the kinematic mechanisms,
(3) Redundant means of extending the landing gear,
(4) Demonstration of proper operation by test,
(5) Gear up-and-locked and down-and-locked position indications and aural warning.
(6) Equipment damage from tire burst, loose tread, and wheel brake temperatures.

b. Demonstration of Retracting mechanism Proper Functioning (Reference §25.729(d) *Operation test*) Guidance addressing flight testing used to demonstrate compliance with this section may be found in Advisory Circular (AC) 25-7A, Flight Test Guide for Transport Category Airplanes, chapter 4, section 4, paragraph 52, issued June 3, 1999.

c. Retracting Mechanism Indication: (Reference §25.729(e) *Position indicator and warning device*).

(1) When light indicators are used, they should be arranged so that-
(a) A green light for each unit is illuminated only when the unit is secured in the correct landing position.
(b) A warning light consistent with § 25.1322 is illuminated at all times except when the landing gear and its doors are secured in the landing or retracted position.
(2) The warning required by § 25.729(e)(2) should preferably operate whatever the position of wing leading- or trailing-edge devices or the number of engines operating.

(3) The design should be such that nuisance activation of the warning is minimized, for example-
a. When the landing gear is retracted after a take-off following an engine failure, or during a take-off when a common flap setting is used for take-off and landing;
b. When the throttles are closed in a normal descent; or
c. When flying at low altitude in clean or low speed configuration (special operation).

(4) Inhibition of the warning above a safe altitude out of final approach phase either automatically or by some other means to prevent these situations is acceptable, but it should automatically reset for a further approach.

(5) Means to de-activate the warning required by § 25.729(e) may be installed for use in abnormal or emergency conditions provided that it is not readily available to the flight crew, i.e. the control device is protected against inadvertent actuation by the flight crew and its de-activated state is obvious to the flight crew.

d. Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance): (Reference §25.729(f) *Protection of equipment on landing gear and in wheel wells*),

(1) The use of fusible plugs in the wheels is not a complete safeguard against damage due to tire explosion.

(2) Where brake overheating could be damaging to the structure of, or equipment in, the wheel wells, an indication of brake temperature should be provided to warn the pilot.

f. Definitions. For definitions of V_S, V_{S1}, and V_C, see 14 CFR Part 1, section 1.2, titled Abbreviations and symbols.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

The harmonized rule merges existing FAR/JAR requirements and industry practices which have resulted in safe aircraft systems with proven service experience. The proposed advisory material for § 25.729 collects existing advisory material which should facilitate consistent compliance methods across the industry.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The level of safety will be improved for landing gear retracting mechanisms certified to the requirements of the FAA because the proposed standard retains all of the existing FARs and adds the minor clarifications that are found in the JARs.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

For 25.729(a) through (d), and (f) the proposed standard is not significantly changed and therefore will maintain the same level of safety.
For 25.729(e) the proposed standard is based on recent amendments (FAA Amendment 25-75, Dec. 5, 1991 and JAA Change 14, Amendment 93/1, March, 8, 1993) which were incorporated to make the regulation more compatible with the design of modern jet aircraft. As a result the proposed standard will maintain the same level of safety.

10 - What other options have been considered and why were they not selected?: [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]

The following options to the regulation were considered but were not selected because this exercise is using the "fast track" process which involves simple enveloping of the more stringent of the FAA or JAA regulation. Efforts should be made in the future to consider the following potential options to the regulation.

The following paragraph numbers identify options that were considered for the proposed regulation and advisory material:

<u>Regulation:</u>
§ 25.729(a)(1)(iii)
A sentence should be added to clarify that this regulation applies to the strength of the landing gear retracting mechanism, wheel well doors, and supporting structure and does

not require that the landing gear actuation system must be able to retract the landing gear under these loading conditions. The Flight Test Guide for Certification of Transport Category Airplanes, FAA AC 25-7A, Section 4 Landing Gear, specifically identifies that demonstration of landing gear actuation system capability be conducted at near 1 g flight.

§ 25.729(c)
The word "alternate" should replace the word "emergency" in describing the secondary means of extending the landing gear. Use of the secondary landing gear extension means should not imply an emergency situation.

§ 25.729(c)(1)
The term "reasonably probable" should be replaced by "single" in describing the failures that must be addressed by the alternate means of extending the landing gear. The word "probable" has connotations from 25.1309 that may be construed to mean single failures that are less likely than probable need not be considered. Jams of primary joints are excluded since a complete jam will prevent extension of the single affected landing gear by normal or alternate means. The term jam includes elements that hang up the gear as well as excessive joint friction. The intent of this subparagraph would then be similar to FAR 25.671(c)(1).

§ 25.729(e)
The rule could be generalized to require indication to the pilots of landing gear position status rather than specifically the extended or retracted positions. Modern quiet, dark flight decks usually do not have a specific indication for landing gear "secured in the retracted position."

§ 25.729(e)(XX)
A paragraph should be added to emphasize the specific need for the ability to determine individual gear extended status regardless of gear command status.

§ 25.729(e)(7)
Text should be modified to remove the word "warning" because "warning" per 25.1322 has a specific meaning that is not consistent with normal operation of the landing gear. The text should be moved to group the "indication" requirements together.

§ 25.729(f)
The word "essential" should be replaced by the word "required." The word "essential" has taken on a criticality connotation under D0-178A, Software Considerations in Airborne Systems and Equipment Certification, paragraph 5.2.1, and it implies the rule only considers equipment damage from tire failures that would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions and that consequences of greater criticality are not considered. This is not the intent of the rule.

<u>Advisory Material: (Ref: Current JAR ACJ 25.729(e) and (f)</u>
AC 25.729-1X paragraph 4.(c)(1)

To account for the increased use of programmable display screens in the flight deck, the words "Light indicators..." should be replaced by "Landing gear position indicators..."

AC 25.729-1X paragraph 4.(c)(1)(a)
The words "light" and "illuminated" should be replaced by "colored indicator" and "displayed" respectively to include other indicator methods such as programmable display screens.

AC 25.729-1X paragraph 4.(c)(1)(b)
The word "light" should be replaced by "indicator" and the meaning of the text should be modified to allow the multiple color options and display timing allowed by modern programmable display screens. Per § 25.1322, the word warning means "a hazard which may require immediate corrective action" and illumination of a warning light is not desirable for any time the gear position is in transit. The text should include provisions for indicators, such as lights, that do not have multiple color capability.

AC 25.729-1X paragraph 4.(c)(2)
The word "whatever" should be replaced by "independent of" to more accurately convey the intent.

AC 25.729-1X paragraph 4.(c)(3)
The introduction text should be revised to not repeat § 25.729(e)(5) but give examples of false or inappropriate alerts.

AC 25.729-1X paragraph 4.(c)(5)
The text should be revised to be less redundant and more aligned with § 25.729(e)(4).

AC 25.729-1X 4.(d)(1)
The word "explosion" should be replaced by the word "burst." Explosion implies the combustion of oxygen and hydrocarbons and is not the intent of the text. Protection from tire explosion is addressed by § 25.733(e).

AC 25.729-1X 4.(d) should be extensively modified because §§ 25.729(f)(1) and (2) are vague. The efforts by the JAA, via Certification Review Items (CRIs), to standardize the compliance methods for tire burst and loose tread are commendable but have been inconsistent by offering a mixture of definitions either of the particular threat or of the damage zone caused by the threat. It has become clear that there is a wide array of experience among manufacturing and certification agencies on what the definition of a tire burst, or a thrown tread is, i.e. what size, how fast, how often, what energy transfer. Due to the complexity of the issue and the constraints of the "fast track" process, the proposed standard has not attempted to change the existing tire threat standards. In a separate harmonization effort, the advisory material should be revised to prioritize the 25.729(f)(1) and (2) compliance approach by emphasizing separation and damage zones and only trying to quantify the threat definition as a last resort.

AC 25.729-1X paragraph 4.(d)(2)

The text should be modified to reflect that brake temperature indication to the flight crew should be provided only if the combination of damaged equipment would prevent continued safe flight and landing. Damage to individual pieces of equipment or structure is acceptable if safe flight and landing capability are not jeopardized.

In addition to the changes considered for the above regulation and advisory material paragraphs, the following is a summary of policy material from the FAA that was reviewed for inclusion in the new AC. In most cases this policy material was generated in response to specific proposed designs, and was thus not appropriate for inclusion in the proposed advisory material. However, the policy material is still valid and details for the following topics can be found in AC 25-22, Certification of Transport Airplane Mechanical Systems: (issued March 14, 2000).

1. Landing Gear Slush Tests
2. Landing Gear Position Indication System - "Backup Requirement
3. Flap System/Landing Gear Warning System Tie-In
4. Landing Gear Position Indication System
5. Protection of Equipment on Landing Gear and in Wheel Wells

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Airplane manufacturers are primarily affected although the proposed standard for § 25.729 is not significantly changed from the existing regulations. Future development of a compliance method for §§ 25.729(f)(1) and (2) would benefit manufacturers that currently spend considerable time and money in evaluating tire burst and loose tread consequences.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

FAA AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes, FAA AC 25-22, Certification of Transport Airplane Mechanical Systems (includes policy letters), JAA ACJ 25.729(e), Retracting Mechanism (Interpretative Material), and § 25.729(f), Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance), are desirable to retain however they should be retained separately as advisory material. The proposed advisory material includes information from these ACs and ACJ's. A proposed preamble for § 25.729 follows:

PREAMBLE

SUMMARY: This notice proposes to harmonize the FAA and JAA requirements for landing gear retracting mechanisms. This action is in response to the Aviation Rulemaking Advisory Committee (ARAC) Mechanical Systems Harmonization Working

Group recommendation to harmonize paragraph 25.729 of the Joint Aviation Requirements (JAR) with § 25.729 of the Federal Aviation Regulations (FAR).

GENERAL DISCUSSION

The intent of this rule is to combine the requirements of the Federal Aviation Regulations (FAR)section 25.729, and the Joint Aviation Requirements (JAR) 25.729 into one rule. The rule format and wording is identical to the existing JAR requirements. Appropriate advisory material from AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes; JAR ACJ 25.729(e), Retracting Mechanism (Interpretative Material); and ACJ 25.279(f), Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance) is included.

Changes to Existing FAR/JAR Text

Because of the "fast track" process, no changes were made to the existing FAR/JAR text. In all cases the more stringent of the FAR or JAR wording was incorporated to create the following regulations and advisory material.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

[]

Existing FAA advisory material pertaining to FAR 25.729 is:

1. AC 25-7A, Flight test Guide for Certification of Transport Category Airplanes, dated June 3, 1999.
2. AC 25-22, Certification of Transport Airplane Mechanical Systems, dated March 14, 2000.

Existing JAA advisory material pertaining to JAR 25.729 is:

1. ACJ 25.729(e) - Retracting Mechanism (Interpretative Material)
2. ACJ 25.729(f) - Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance)

This material is useful and should be updated to the proposed rule. Portions of this material are included in the proposed AC 25.729-1X

14 - How does the proposed standard compare to the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

"Due to their commitments as ICAO members the US and all JAA countries converted ICAO requirements into their airworthiness codes. So both the JAR and FAR 25 at least fulfill the ICAO minimum standards. As the proposed standard does not decrease the level of safety of FAR or JAR 25, it is in line with ICAO Annex 8 "Airworthiness of Aircraft"."

15 - Does the proposed standard affect other HWG's? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]

No, however, for the future development of advisory material defining tire burst and loose tread models, the definition of thrown tire tread should be coordinated with the definition being developed for FAR/JAR 25.963(g) advisory material however, because § 25.729(f) pertains to systems and § 25.963(g) pertains to wing structure, the definitions may not necessarily have to be identical.

16 - What is the cost impact of complying with the proposed standard? [Is the overall cost impact likely to be significant, and will the costs be higher or lower? Include any cost savings that would result from complying with one harmonized rule instead of the two existing standards. Explain what items affect the cost of complying with the proposed standard relative to the cost of complying with the current standard.]

The proposed new standard will reduce the overall cost and time of the joint certification process and will not increase cost for any present major manufacturer that has a service demonstrated safety record.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]

The "Fast Track" process is appropriate for the scope of this harmonization effort.

For future clarification of the rule and existing advisory material and the future development of advisory material for § 25.729(f), the fast track process is probably not appropriate based on the extent of the proposed changes and the complexity of compliance demonstration for § 25.729(f) during the 737NG and 767-400ER programs. The eventual advisory material for § 25.729(f) will require extensive negotiation and data sharing requiring several face to face meetings. In addition, the experience and data from

tire manufacturers and airframe manufacturers other than Boeing should be considered prior to defining the final § 25.729(f) means of compliance advisory material.

Revised by M.Wahi on 1-26-2000.

#2

ARAC WG Report FAR/JAR 25.1439
Category 1

23007

1 – What is the underlying safety issue addressed by the FAR/JAR

Smoke, excessive Carbon Dioxide, or toxic gases on the flight deck can inhibit, or prevent the flight crew from performing their duties, which can lead to unsafe conditions. Also, unavailability of sufficient fire fighting equipment, on the flight deck or in accessible compartments, can lead to unsafe conditions. The FAR/JAR define design and installation requirements for portable and stationary Protective Breathing Equipment to ensure safe operation if a fire, or adverse environment develops.

2 – What are the current FAR and JAR standards?

FAA REQUIREMENTS

§ 25.1439 **Protective Breathing Equipment**

(a) If there is a class A, B, or E cargo compartment, protective breathing equipment must be installed for the use of appropriate crewmembers. In addition, protective breathing equipment must be installed in each isolated separate compartment in the airplane, including upper and lower lobe galleys, in which crewmember occupancy is permitted during flight for the maximum number of crewmembers expected to be in the area during any operation.

(b) For protective breathing equipment required by paragraph (a) of this section or by any operating rule of this chapter, the following apply:

(1) The equipment must be designed to protect the flight crew from smoke, carbon dioxide, and other harmful gases while on flight deck duty and while combating fires in cargo compartments

(2) The equipment must include-

(i) Masks covering the eyes, nose, and mouth; or

(ii) Masks covering the nose and mouth, plus accessory equipment to cover the eyes.

(3) The equipment, while in use, must allow the flight crew to use the radio equipment and to communicate with each other, while at their assigned duty stations.

(4) The part of the equipment protecting the eyes may not cause any appreciable adverse effect on vision and must allow corrective glasses to be worn.

(5) The equipment must supply protective oxygen of 15 minutes duration per crewmember at a pressure altitude of 8,000 feet with a respiratory minute volume of 30 liters per minute BTPD. If a demand oxygen system is used, a supply of 300 liters of free oxygen at 70°F. and 760mm Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. If a continuous flow protective breathing system is used (including a mask with a standard rebreather bag) a flow rate of 60 liters per minute at 8,000 feet (45 liters per minute at sea level) and a supply of 600 liters of free oxygen at 70° F. and 760 mm. Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. BTPD refers to body temperature conditions (that is, 37° C., at ambient pressure, dry).

(6) The equipment must meet the requirements of paragraphs (b) and (c) of §25.1441.

[Doc. No. 5066, 29 FR 18291, Dec.24, 1964, as amended by Amdt. 25-38, 41 FR 55468, Dec. 20, 1976]

JAA REQUIREMENTS

JAR 25.1439 **Protective Breathing Equipment**

(a) Protective breathing equipment must be installed for use of appropriate crew members. Such equipment must be located so as to be available for use in compartments accessible in flight.

(b) For protective breathing equipment required by JAR 25.1439 (a) or by the National Operating Regulations, the following apply:

(1) The equipment must be designed to protect the appropriate crew member from smoke, carbon dioxide, and other harmful gases while on flight deck duty or while combating fires.

(2) The equipment must include --

(i) Masks covering the eyes, nose and mouth, or

(ii) Masks covering the nose and mouth, plus accessory equipment to cover the eyes.

(3) Equipment, including portable equipment, while in use must allow communication with other crew members. Equipment available at flight crew assigned duty stations must enable the flight crew to use radio equipment.

(4) The part of the equipment protecting the eyes may not cause any appreciable adverse effect on vision and must allow corrective glasses to be worn.

(5) Each dispensing equipment must supply protective oxygen of 15 minutes duration at a pressure altitude of 8000 feet with a respiratory minute volume of 30 litres per minute BTPD. The equipment and system must be designed to prevent any leakage to the inside of the mask and any significant increase in the oxygen content of the local ambient atmosphere. (See ACJ 25.1439 (b)(5).)

(6) The equipment must meet the requirements of JAR 25.1441.

ACJ 25.1439(b)(5) - **Protective Breathing Equipment (Interpretive Material and Acceptable Means of Compliance)**

See JAR 25.1439(b)(5)

1 If a demand system is used, a supply of 300 litres of free oxygen at 70° and 760 mm Hg pressure is considered to be of 15 minutes duration at the prescribed altitude and minute volume. (Interpretive Material.)

2 Any other system such as a continuous flow system is acceptable provided that it does not result in any significant increase in the oxygen content of the local ambient atmosphere above that which would result from the use of a demand oxygen system. (Interpretive Material.)

3 A system with safety over-pressure would be an acceptable means of preventing leakage. (Acceptable Means of Compliance.)

4 A continuous flow system of the closed circuit rebreather type is an acceptable system. (Acceptable Means of Compliance.)

3- What are the differences in the standards and what do these differences result in?

Paragraph (a)
FAR 25.1439 requires Protective Breathing Equipment (hereafter referred to as PBE in this report) if there is a class A, B, or E cargo compartment. It also requires PBE in each isolated separate compartment, where crew member occupancy is permitted during flight, for the maximum number of crewmembers expected to occupy that area during any operation. JAR 25.1439 requires PBE to be available for use in any compartment that is accessible in flight, regardless of compartment classification, or isolation.

Paragraph (b)
The FAR and JAR are essentially the same, referring to paragraph (a) and operating regulations.

Paragraph (b)(1)
The FAR specifies that the equipment must be designed to protect the flight crew while on duty, and while combating fires in cargo compartments. The JAR specifies protection for the appropriate crew member (not just flight crew) and doesn't limit the fire combating to cargo compartments.

Paragraph (b)(2) - No differences

Paragraph (b)(3)
The FAR and JAR list essentially the same requirements for communication to other crew members and allowing use of radio equipment. The only difference is that the JAR clarifies that the rule applies to both stationary and portable equipment.

Paragraph (b)(4) - No differences

Paragraph (b)(5)
Both the FAR and JAR state that the equipment must supply protective oxygen of 15 minute duration per crewmember at a pressure of 8,000 feet with a respiratory minute volume of 30 liters per minute BTPD. The FAR includes interpretive material for a 15 minute duration using demand or continuous flow systems, and defines BTPD. The JAR refers to ACJ 25.1439(b)(5) for the interpretive material, which only describes the 15 minute duration using a demand system.

The JAR includes additional design requirements to prevent internal leakage and to prevent increased oxygen content of the local atmosphere due to external leakage.

Paragraph (b)(6)
The JAR specifies that the equipment must meet all paragraphs of 25.1441 (not just (b) and (c) like the FAR)
Note: FAR/JAR 25.1441 are not identical, but essentially the same.

4- What, if any, are the differences in the means of compliance?

There is no difference in the means of compliance for the stationary type of PBE. All aircraft are equipped with a demand oxygen system for the flight crew, consisting of a high pressure gaseous oxygen supply (minimum of 300 liters of free oxygen per person), pressure/flow regulation, distribution tubing, and masks (or mask and goggle combination if separate) that meet TSO-C99 and JTSO-C99.

The means of compliance for the quantity and location of portable type PBE is slightly different. JAA certified aircraft have at least one PBE installed on the flight deck, and in/near each compartment accessible in flight. Some, but not all, FAA certified aircraft have portable PBE installed on the flight deck. FAA certified aircraft have PBE installed in/near each class A, B, and E cargo compartments (as defined by FAR 25.857). Also, PBE is installed in/near each isolated separate compartment. These compartments include, but are not limited to upper and lower lobe galleys.

Of course those compartments or areas with special conditions against them, are not discussed in this report. The requirements and means of compliance are documented separately.

5- What is the proposed action?

The proposed action is to merge the requirements of both FAR and JAR rules, and develop a baseline set of standards and acceptable means of compliance that satisfy all authorities. The merged rule will combine the requirements of FAR 25.1439 and JAR 25.1439 into one harmonized rule, and eliminate the need for ACJ 25.1439(b)(5). The harmonization will be accomplished by enveloping (taking the most stringent requirement of) the two rules, and adding some of the interpretive material from the ACJ. The result will be a common regulation that is easy to understand.

6- What should the harmonized standard be?

25.1439 Protective Breathing Equipment

(a) Fixed (stationary, or built in) protective breathing equipment must be installed for the use of the flight crew, and at least one portable protective breathing equipment shall be located at or near the flight deck for use by a flight crew member. In addition, portable protective breathing equipment must be installed for the use of appropriate crew members for fighting fires in compartments accessible in flight. This includes isolated compartments, upper and lower lobe galleys, in which crew member occupancy is permitted during flight. Equipment must be installed for the maximum number of crew members expected to be in the area during any operation.

(b) For protective breathing equipment required by [FAR or JAR] 25.1439 (a) or by the applicable Operating Regulations, the following apply:

(1) The equipment must be designed to protect the appropriate crew member from smoke, carbon dioxide, and other harmful gases while on flight deck duty or while combating fires.

(2) The equipment must include -

(i) Masks covering the eyes, nose and mouth, or

(ii) Masks covering the nose and mouth, plus accessory equipment to cover the eyes.

(3) Equipment, including portable equipment, while in use must allow communication with other crew members. Equipment available at flight crew assigned duty stations must also enable the flight crew to use radio equipment.

(4) The part of the equipment protecting the eyes shall not cause any appreciable adverse effect on vision and must allow corrective glasses to be worn.

(5) The equipment must supply protective oxygen of 15 minutes duration per crewmember at a pressure altitude of 8,000 feet with a respiratory minute volume of 30 liters per minute BTPD. The equipment and system must be designed to prevent any inward leakage to the inside of the device and prevent any outward leakage causing significant increase in the oxygen content of the local ambient atmosphere. If a demand oxygen system is used, a supply of 300 liters of free oxygen at 70°F. and 760mm Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. If a continuous flow protective breathing system is used (including a closed circuit rebreather type system) a flow rate of 60 liters per minute at 8,000 feet (45 liters per minute at sea level) and a supply of 600 liters of free oxygen at 70° F. and 760 mm. Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. Continuous flow systems must not increase the ambient oxygen content of the local atmosphere above that of demand systems. BTPD refers to body temperature conditions (that is, 37° C., at ambient pressure, dry).

(6) The equipment must meet the requirements of [FAR or JAR] 25.1441.

7- How does this proposed standard address the underlying safety issue (identified under #1)?

The revised regulation clearly defines design and compliance criteria for stationary and portable protective breathing equipment in one harmonized rule. It incorporates the more stringent portions of the existing FAR/JAR requirements.

8- Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety?

The proposed standard may increase the safety of aircraft certified to part 25 of the FAA regulations, but maintains the same level of safety for aircraft certified to the JARs. For some configurations the revised FAA rule will require additional portable PBE to be installed by the airframe Original Equipment Manufactures (OEMs). Most operating rules, such as FAR 121.337 and JAR-OPS 1.780, require additional portable PBE above what is required for type-design certification. Some operating rules may not require as many portable PBE as FAR/JAR 25.1439. The only increase in safety would come from the situation where the airline's applicable operational requirements are the same as, or less than the current FAR 25.1439.

9- Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Airlines and OEMs typically configure the aircraft, at the time of design, with more PBE than is required by FAR/JAR 25.1439. The current industry practice is to install PBE in accordance with the more stringent requirements of part 25 and the applicable operational rules. As noted above, the operational requirements typically require more portable PBE than part 25. Therefore, the proposed revision to the standard, would maintain the same level of safety.

10- What other options have been considered and why were they not selected?

Enveloping (taking the most stringent requirement of each) FAR 25.1439, JAR 25.1439, FAR 121.337, and JAR-OPS 1.780 into one harmonized FAR/JAR 25.1439 was considered. This option was not selected since it would be out of the scope of the Harmonization Working Group's task and objectives. Revising FAR 25.1439 and JAR 25.1439 to include some operational requirements would likely drive changes to FAR 121.337 and JAR-OPS 1.780. Changes to these requirements would take considerable effort and would thus not be appropriate for the "Fast Track" process.

11- Who would be affected by the proposed change?

Airlines typically purchase portable PBE and flight crew masks, and provide them to the airframe OEMs for installation. The proposed change to the rule will require additional portable PBE to be installed on some aircraft. Additional units would increase the airlines' procurement costs, and increase the airplane manufacturer's installation cost.

12- To ensure harmonization, what current advisory material (e.g. ACJ, AMJ, AC policy letters) needs to be included in the rule text or preamble?

The text of the proposed rule incorporates the interpretive material (paragraphs 1 and 2) and acceptable means of compliance (paragraph 4) of ACJ 25.1439(b)(5). The remainder of ACJ 25.1439(b)(5) will be eliminated.

The preamble should include:

PREAMBLE

SUMMARY: This notice proposes to revise the requirements for protective breathing equipment. This action is in response to the Aviation Rulemaking Advisory Committee (ARAC) Mechanical Systems Harmonization Working Group recommendation to harmonize 25.1439 of the Joint Aviation Requirements (JAR) with part 25.1439 of the Federal Aviation Regulations (FAR).

BACKGROUND

On November 26, 1999 the FAA issued a notice of a new task to harmonize FAR 25.1439 with JAR 25.1439. The notice was issued to inform the public that the FAA has asked ARAC to provide advice and recommendations on harmonization of the FAA regulations and JAA requirements for protective breathing equipment. This notice of Proposed Rulemaking proposes a revised protective breathing equipment rule that has been harmonized to satisfy both the FAA and JAA.

General Discussion:

The intent of this rule is to combine the requirements of section 25.1439 of the Federal Aviation Regulations (FAR), and paragraph 25.1439 of the Joint Aviation Requirements (JAR), and the advisory material for paragraph 25.1439(b)(5) of the JAR into one rule. The rule format is similar to the existing material for FAR 25.1439. This rule applies to design and installation of stationary and portable protective breathing equipment.

This rule has been changed to include the more stringent requirements of FAR 25.1439 and JAR 25.1439. Paragraphs (b)(5) and (b)(6) of the existing JAR 25.1439 are more stringent than the existing FAR 25.1439. These paragraphs include additional leakage and design requirements above the existing FAR. Paragraph (a) of the existing JAR requires protective breathing equipment to be installed for fire fighting use in all compartments

accessible in flight, not just specific cargo compartments. Paragraph (a) of the existing FAR 25.1439 requires portable protective breathing equipment for each crew member in isolated compartments; the JAR requires the equipment for use of the appropriate crew members.

The proposed changes in the rule reflect current airplane Original Equipment Manufacture (OEM) design practices for some commercial transport models that have already been shown to meet JAR 25.1439; however, all models not currently certified by the JAA would be affected by the rule harmonization. New models to be certified to the harmonized FAR 25.1439 will be affected.

Proposed Rule Discussion:

Paragraph (a) of the proposed, harmonized rule is written to define the installation requirements for stationary and portable protective breathing equipment. The rule specifies the areas where protective breathing equipment is required, and differentiates between portable and stationary equipment for the use of the appropriate crew members.

Paragraph (b)(1) of the proposed, harmonized rule is written to define the design requirements for protective breathing equipment. This paragraph specifies the requirements to allow the flight crew to continue performing their duties, and to allow other crew members to combat fires. The rule defines the emergency environmental conditions which must be considered when demonstrating compliance to the requirement.

Paragraph (b)(2) of the proposed, harmonized rule is written to define design requirements for the mask portion of stationary protective breathing equipment. The rule specifies the protection level that the equipment must provide.

Paragraph (b)(3) of the proposed, harmonized rule is written to define design requirements for stationary and portable protective breathing equipment. The rule specifies that stationary equipment for the flight crew must allow communication with other crew members, and must allow usage of radio equipment. The rule also states that portable protective breathing equipment must allow communication with other crew members.

Paragraph (b)(4) of the proposed, harmonized rule is written to define design requirements for the eye protection portion of the equipment. The paragraph states that the effects of the equipment on vision must be negligible, with or without corrective eyeglasses being worn.

Paragraph (b)(5) of the proposed, harmonized rule is written to define additional design requirements for stationary and portable protective breathing equipment, and to provide interpretive material. This paragraph specifies performance based requirements for demand and continuous flow systems. Specifically, the rule ensures that the design must have adequate oxygen flowrate, system duration, and leakage limits to protect the crew members, when the equipment is needed.

Paragraph (b)(6) of the proposed, harmonized rule is written to define design requirements for protective breathing systems. The rule doesn't specifically address the design parameters, rather it refers to FAR/JAR 25.1441. FAR/JAR 25.1441 defines the requirements for the minimum mass flow of supplemental oxygen, standards for oxygen distribution systems and dispensing units, and determining available quantity of oxygen. It also defines the requirements for preventing hazards to other systems due to excessive temperatures, rupture, or leakage.

13- Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

There isn't any existing FAA advisory material for FAR 25.1439. The proposed harmonized rule does not need any new FAA advisory material.

14- How does the proposed standard compare to the current ICAO standard?

The United States and the JAA countries converted ICAO requirements into their respective airworthiness codes. The FAR part 25 and JAR meet or exceed the ICAO Annex 8 "Airworthiness of Aircraft". The proposed FAR/JAR 25.1439 maintains or increases the level of safety of the existing FAR and JAR, so the ICAO standards are still met.

15- Does the proposed standard affect other HWG's?

No other Harmonization Working Groups are affected by the proposed revision to the standard.

16- What is the cost impact of complying with the proposed standard?

The airplane manufacture's increased installation costs will be approximately 1 hour or $150.00 for each additional portable PBE required. It is estimated that less than one additional unit, on average will be required per aircraft.

The increased procurement costs will be approximately $1,500.00 for each additional portable PBE required.

17- Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

The Mechanical Systems Harmonization Working Group should review the draft NPRM prior to publication.

18- In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process? Explain.

The "Fast Track" is appropriate for this rule. The proposed changes are straight forward, and shouldn't be too controversial.

ARAC WG Report FAR/JAR 25.1453
Category 1

99356
N/A

1. – What is the underlying safety issue addressed by the FAR/JAR

The FAR / JAR define design and installation requirements for built in oxygen systems. An oxygen leak or an oxygen source / tubing location not adequately chosen with respect to the surrounding environment (ambient temperature) and crash landing may create hazardous situations from a fire safety point of view.
Oxygen by itself is stable and non-flammable. However, it does support and accelerate combustion. Once a fire starts, localized oxygen build-up due to a leak could cause adjacent substances to burn more rapidly or even explosively in the presence of combustible like oil, grease etc. .
Therefore, care must be taken to assure that the test conditions used in certification accurately reflect (or exceed in severity) the environment in which the material is to be used and that operational effects are included in the testing procedures. Elimination of the ignition source, requires controlling temperatures in the system including that of the gas.

2. – What are the current FAR and JAR standards?

FAA REQUIREMENTS

§ 25.1453 Protection of oxygen equipment from rupture

Oxygen pressure tanks, and lines between tanks and the shutoff means must be -

(a) Protected from unsafe temperatures; and
(b) Located where the probability and hazard of rupture in a crash landing are minimized.

JAA REQUIREMENTS

JAR 25.1453 Protection of oxygen equipment from rupture
(See ACJ 25.1453.)

(a) Each element of the system must have sufficient strength to withstand the maximum pressures and temperatures in combination with any externally applied load, arising from consideration of limit structural loads that may be acting on that part of the system in service.

(b) Oxygen pressure sources and pipe lines between the sources and shut-off means must be -
(1) Protected from unsafe temperatures; and
(2) Located where the probability and hazard of rupture in a crash landing are minimized.

ACJ 25.1453
Protection of Oxygen Equipment from Rupture (Interpretative Material)
See JAR 25.1453

1 Parts of the system subjected to high oxygen pressure should be kept to a minimum and should be remote from occupied compartments. Where such parts are installed within occupied compartments they should be adequately protected from accidental damage.

2 Each container, component, pipe and coupling should have sufficient strength to withstand a pressure equivalent to not less than the maximum working pressure acting on that part of the system when multiplied by the appropriate Proof and Ultimate factors given in Table 1. The maximum working pressure includes tolerances of any pressure limiting means and possible pressure variations in the normal operating modes. Account should also be taken of the effects of temperature up to the maximum anticipated temperature to which the system may be subjected. Transient or surge pressures need not be considered except where these exceed the maximum working pressure multiplied by 1·10.

Systems Element	Proof Factor	Ultimate Factor
Containers	1·5	2·0
Flexible hoses	2·0	4·0
Pipes and couplings	1·5	3·0
Other components	1·5	2·0

3 Each source should be provided with a protective device (e.g. rupture disc). Such devices should prevent the pressure from exceeding the maximum working pressure multiplied by 1·5.

4 Pressure limiting devices (e.g. relief valves), provided to protect parts of the system from excessive pressure, should prevent the pressures from exceeding the applicable maximum working pressure multiplied by 1·33 in the event of malfunction of the normal pressure controlling means (e.g. pressure reducing valve).

5 The discharge from each protective device and pressure limiting device should be vented overboard in such a manner as to preclude blockage by ice or contamination, unless it can be shown that no hazard exists by its discharge within the compartment in which it is installed. In assessing whether such hazard exists consideration should be given to the quantity and discharge rate of the oxygen released, the volume of the compartment into which it is discharging, the rate of ventilation within the compartment and the fire risk due to the installation of any potentially flammable fluid systems within the compartment.

6 In addition to meeting the requirements of JAR 25.1453, oxygen containers may have to be approved in accordance with national regulations.

NOTES:

1 The proof pressure should not cause any leakage or permanent distortion.

2 The ultimate pressure should not cause rupture but may entail some distortion.

3. What are the differences in the standards and what do these differences result in?

JAR paragraph (a)

There is no equivalent FAR paragraph. JAR 25.1453 (a) require each element of the system to have sufficient strength to withstand the maximum pressures and temperatures in combination with externally applied loads. Demonstration should be done by using proof pressure and ultimate pressure coefficients specified in ACJ 25.1453.

FAR Introductory paragraph, paragraph (a) and (b) / JAR paragraph (b)

JAR 25.1453 (b) is comparable to the introductory paragraph of FAR 25.1453. JAR use the term sources instead of tanks and pipes lines instead of lines.

JAR 25.1453(b)(1) is equivalent to FAR 25.1453 (a).
JAR 25.1453 (b)(2) is equivalent to FAR 25.1453 (b).

The above described differences may result in different design standards as far as strength of the system is concerned.

4. What, if any, are the differences in the means of compliance?

JAR 25.1453 cross reference the ACJ 25.1453 which is an Interpretative Material of the requirement. The ACJ defines :

- acceptable locations for high oxygen pressure parts
- proof pressure and ultimate pressure factors each component should be designed to
- protective device and pressure limiting device the system should include

The above described differences may result in different design standards as far as locations of systems components, pressure limiting and protective devices are concerned.

5. What is the proposed action?

The proposed action is to merge the requirements of both FAR, JAR and ACJ rules, and develop a baseline set of standards to satisfy all authorities. The merged rule will combine the requirements of FAR 25.1453 and JAR 25.1453 into one harmonized rule, and eliminate the need for the ACJ 25.1453. The harmonization will be accomplished by enveloping (taking the most stringent requirement of) the two rules, and adding some of the interpretive material from the ACJ. The result will be a common regulation that is easy to understand.

6. What should the harmonized standard be?

25.1453 Protection of oxygen equipment from rupture

(a) Each element of the system ,excluding chemical oxygen generators, must have sufficient strength to withstand the maximum normal operating pressures, including transients, and temperatures in combination with any externally applied load, arising from consideration of limit structural loads that may be acting on that part of the system in service.

(1) The maximum normal operating pressure must include tolerances of any pressure limiting means and possible pressure variations in the normal operating modes. Transient or surge pressures need not be considered except where these exceed the maximum normal operating pressure multiplied by 1·10.

(2) Account must be taken of the effects of temperature up to the maximum anticipated temperature to which the system may be subjected.

(3) Strength demonstration using proof pressure and burst pressure coefficients specified in Table 1 is acceptable, unless higher loads result when elements are subjected to combined pressure, temperature and structural loads.

(i) The proof and burst factors in Table 1 must be applied to maximum normal operating pressure

obtained from (a)(1) with consideration given to the temperature of (a)(2).

(ii) Proof pressure must be held for a minimum of 2 minutes and must not cause any leakage or permanent distortion.

(iii) Burst pressure must be held for a minimum of 1 minute and must not cause rupture but some distortion is allowed.

TABLE 1

Systems Element	Proof Factor	Burst Factor
Cylinders (i.e. pressure vessels)	1·5	2·0
Flexible hoses	2·0	4·0
Pipes and couplings	1·5	3·0
Other components	1·5	2·0

(4) Oxygen cylinders, excluding chemical oxygen generators, may have to be approved in accordance with national regulations.

(b) Oxygen pressure sources and tubing between the sources and shut-off means must be -

(1) Protected from unsafe temperatures, and

(2) Located where the probability and hazard of rupture in a crash landing are minimized.

(c) Parts of the system subjected to high oxygen pressure must be kept to a minimum and must be remote from occupied compartments to the extent practicable. Where such parts are installed within occupied compartments they must be protected from accidental damage.

(d) Each pressure source (e.g. tanks or cylinders) must be provided with a protective device (e.g. rupture disc) Such devices must prevent the pressure from exceeding the maximum working pressure multiplied by 1·5.

(e) Pressure limiting devices (e.g. relief valves), provided to protect parts of the system from excessive pressure, must prevent the pressures from exceeding the applicable maximum working pressure multiplied by 1·33 in the event of malfunction of the normal pressure controlling means (e.g. pressure reducing valve).

(f) The discharge from each protective device and pressure limiting device must be vented overboard in such a manner as to preclude blockage by ice or contamination, unless it can be shown that no hazard exists by its discharge within the compartment in which it is installed. In assessing whether such hazard exists consideration must be given to the quantity and discharge rate of the oxygen released, the volume of the compartment into which it is discharging, the rate of ventilation within the compartment and the fire risk due to the installation of any potentially flammable fluid systems within the compartment.

7. How does this proposed standard address the underlying safety issue (identified under #1)?

The revised regulation clearly defines design and compliance criteria for protection of oxygen equipment from rupture in one harmonized rule. It incorporates the more stringent portions of the existing FAR/JAR requirements.

8. Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety?

The proposed standard may increase the safety of aircraft certified to part 25 of the FAA regulations, but maintains the same level of safety for aircraft certified to the JARs.

9. Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed standard maintains the same level of safety relative to current industry practice, which is in compliance with the proposed standard. It is derived in part from the requirements used to design and qualify transport aircraft systems and components of major United States and European manufacturers which have demonstrated their products safe operation in service.

10. What other options have been considered and why were they not selected?

No other options have been considered.

11. Who would be affected by the proposed change?

Airplane manufactures and suppliers will benefit from the single well defined harmonized ruling reducing certification costs. The proposed rule may increase costs for TC or STC applicants manufacturers that have only showed compliance to FAR 25.1453.

12. To ensure harmonization, what current advisory material (e.g. ACJ, AMJ, AC policy letters) needs to be included in the rule text or preamble?

The text of the proposed rule incorporates the entire interpretive material of the ACJ 25.1453
No current advisory material should be included, however the preamble should include the following-

PREAMBLE

SUMMARY:
This notice proposes to revise the requirements for protection of oxygen equipment from rupture. This action is in response to the Aviation Rule making Advisory Committee (ARAC) Mechanical Systems

Harmonization Working Group recommendation to harmonize paragraphs 25.1453 of the Joint Aviation Requirements (JAR) with part 25.1453 of the Federal Aviation Regulations (FAR).

GENERAL DISCUSSION

The intent of this rule is to combine the requirements of section 25.1453 of the Federal Aviation Regulations (FAR), paragraph 25.1453 of the Joint Aviation Requirements (JAR), and the advisory material for paragraphs 25.1453 of the JAR into one rule. The design standards have been placed in the text of the rule instead of the advisory material.

This rule applies to built-in oxygen systems and their elements. For the purpose of this rule, the oxygen elements include the oxygen sources, pipe lines, control devices and components from the oxygen source to the oxygen mask.

The merged rule combine the requirements of FAR 25.1453 and JAR 25.1453 into one harmonized rule, and eliminate the need for the ACJ 25.1453. The harmonization is accomplished by enveloping (taking the most stringent requirement of) the two rules, and adding all of the interpretive material from the ACJ. Because of the "fast track" process, minimal changes is made to the existing FAR/JAR and JAR ACJ text. In all cases the more stringent of the FAR or JAR wording is incorporated to create the following regulations.

13. Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

There isn't any existing FAA advisory material for FAR 25.1453. The proposed harmonized rule does not need any new FAA advisory material.

14. How does the proposed standard compare to the current ICAO standard?

The United States and the JAA countries converted ICAO requirements into their respective airworthiness codes. The FAR part 25 and JAR meet or exceed the ICAO Annex 8 "Airworthiness of Aircraft". The proposed FAR/JAR 25.1453 maintains or increases the level of safety of the existing FAR and JAR, so the ICAO standards are still met.

15. Does the proposed standard affect other HWG's?

No other Harmonization Working Groups are affected by the proposed revision to the standard.

16. What is the cost impact of complying with the proposed standard?

The proposed new standard will reduce the overall cost and time of the joint certification process and will not increase cost for any present major manufacturer that has a service demonstrated safety record. The cost increase, if any, will be negligible compared to the benefits of a clear, concise, and standardized rule. An increase in certification costs may result to those manufactures applying only for FAA type.

17. Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

The Mechanical Systems Harmonization Working Group should review the draft NPRM prior to publication.

18. In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rule making project, or is the project too complex or controversial for the Fast Track Process? Explain.

The "Fast Track" is appropriate for this rule.

Recommendation

ARAC WG Report Format
FAR/JAR 25.729 Retracting Mechanism

1 - What is underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why does the requirement exist?]

This FAR/JAR contains minimum design and certification requirements for airplanes with retractable landing gear. The requirements address:

(a) Loads imposed during flight on the landing gear structure and mechanism,
(b) Positive locking of the kinematic mechanisms,
(c) Redundant means of extending the landing gear,
(d) Demonstration of proper operation by test,
(e) Means of informing the pilot(s) of the landing gear position and lock status,
(f) Equipment damage from tire burst, loose tread, and wheel brake temperatures.

The underlying safety issue is that a retractable landing gear introduces new airplane configurations not found on airplanes with fixed landing gear. The gear up configuration improves climb and cruise performance. The gear down configuration will increase drag and fuel burn and usually has speed limitations due to air loads. Failure of the landing gear to extend for landing exposes the flight crew and passengers to the risk of injury and results in economic damage. A typical flight plan is based in part on appropriate landing gear configurations at the appropriate times. The regulations serve to ensure that the landing gear is in the appropriate or at least most critical configuration when necessary, that the landing gear operates properly, that the flight crew is aware of the landing gear position status, and that the critical systems are retained in the event of tire related failure conditions.

2 - What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]

Current FAR Text

14 Code of Federal Regulations (CFR) 25.729

§ 25.729 Retracting Mechanism.

(a) *General.* For airplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for-

(i) The loads occurring in the flight conditions when the gear is in the retracted position,

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_s

(with the flaps in takeoff position at design takeoff weight), occurring during retraction and extension at any airspeed up to 1.6 V_{s1} (with the flaps in the approach position at design landing weight), and

(iii) Any load factor up to those specified in §25.345(a) for the flaps extended condition.

(2) Unless there are other means to decelerate the airplane in flight at this speed, the landing gear, the retracting mechanism, and the airplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_c.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing maneuvers prescribed for the airplane in addition to the conditions of airspeed and load factor prescribed in paragraphs (a)(1) and (2) of this section.

(b) *Landing gear lock.* There must be positive means to keep the landing gear extended, in flight and on the ground.

(c) *Emergency operation.* There must be an emergency means for extending the landing gear in the event of-

(1) Any reasonably probable failure in the normal retraction system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator and warning device.* If a retractable landing gear is used, there must be a landing gear position indicator (as well as necessary switches to actuate the indicator) or other means to inform the pilot that the gear is secured in the extended (or retracted) position. This means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by paragraph (e)(2) of this section such that it could be operated instinctively, inadvertently, or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to eliminate false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(f) *Protection of equipment in wheel wells.* Equipment that is essential to safe operation of the airplane and that is located in wheel wells must be protected from the damaging effects of-

(1) A bursting tire, unless it is shown that a tire cannot burst from overheat; and

(2) A loose tire tread, unless it is shown that a loose tire tread cannot cause damage.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-23, 35 FR 5676, Apr. 8, 1970; Amdt. 25-42, 43 FR 2323, Jan. 16, 1978;
Amdt. 25-72, 55 FR 29777, July 20, 1990; Amdt. 25-75, 56 FR 63762, Dec. 5, 1991]

Current JAR Text

JAR 25.729 Retracting mechanism

(a) *General.* For aeroplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for--

(i) The loads occurring in the flight conditions when the gear is in the retracted position;

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_s (with the flaps in take-off position at design take-off weight), occurring during retraction and extension at any airspeed up to 1.6 V_{s1} with the wing-flaps in the approach position at design landing weight, and

(iii) Any load factor up to those specified in JAR 25.345 (a) for the wing-flaps extended

condition.

(2) Unless there are other means to decelerate the aeroplane in flight at this speed, the landing gear, the retracting mechanism, and the aeroplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_c.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing manoeuvres prescribed for the aeroplane in addition to the conditions of airspeed and load factor presented in sub-paragraphs (a)(1) and (2) of this paragraph.

(b) *Landing gear lock.* There must be positive means to keep the landing gear extended in flight and on the ground. <u>There must be positive means to keep the landing gear and doors in the correct retracted position in flight, unless it can be shown that lowering of the landing gear or doors, or flight with the landing gear or doors extended, at any speed, is not hazardous</u>.

(c) *Emergency operation.* There must be an emergency means for extending the landing gear in the event of--

(1) Any reasonably probable failure in the normal action system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator and warning device.* (See ACJ 25.729 (e). If a retractable landing gear is used, there must be a landing gear position indicator easily visible to the pilot or to the appropriate crew members (as well as necessary devices to actuate the indicator) to indicate without ambiguity that the retractable units and their associated doors are secured in the extended (or retracted) position. The means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by sub-paragraph (e)(2) of this paragraph such that it could be operated instinctively, inadvertently or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to minimise false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(7) A clear indication or warning must be provided whenever the landing gear position is not consistent with the landing gear selector lever position.

(f) *Protection of equipment on landing gear and in wheel wells.* Equipment that is essential to the safe operation of the aeroplane and that is located on the landing gear and in wheel wells must be protected from the damaging effects of--

(1) A bursting tyre, (see ACJ 25.729 (f);

(2) A loose tyre tread unless it is shown that a loose tyre tread cannot cause damage; and

(3) Possible wheel brake temperatures, (see ACJ 25.729 (f).

Ch. 14 (Amend. 93/1, Eff. 8.3.93)

ACJ 25.729(e) - Retracting Mechanism (Interpretative Material)

See JAR 25.729(e)

1 When light indicators are used, they should be arranged so that-

(a) A green light for each unit is illuminated only when the unit is secured in the correct landing position.

(b) A warning light consistent with JAR 25.1322 is illuminated at all times except when the landing gear and its doors are secured in the landing or retracted position.

2 The warning required by JAR 25.729(e)(2) should preferably operate whatever the position of wing leading- or trailing-edge devices or the number of engines operating.

3 The design should be such that nuisance activation of the warning is minimised, for example-

a. When the landing gear is retracted after a take-off following an engine failure, or during a take-off when a common flap setting is used for take-off and landing;

b. When the throttles are closed in a normal descent; or

c. When flying at low altitude in clean or low speed configuration (special operation).

4 Inhibition of the warning above a safe altitude out of final approach phase either automatically or by some other means to prevent these situations is acceptable, but it should automatically reset for a further approach.

5 Means to de-activate the warning required by JAR 25.729(e) may be installed for use in abnormal or emergency conditions provided that it is not readily available to the flight crew, i.e. the control device is protected against inadvertent actuation by the flight crew and its de-activated state is obvious to the flight crew.

Ch. 14 (Amend. 93/1, Eff. 8.3.93)

ACJ 25.729(f) - Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance)

See JAR 25.729(f)

The use of fusible plugs in the wheels is not a complete safeguard against damage due to tyre explosion.

Where brake overheating could be damaging to the structure of, or equipment in, the wheel wells, an indication of brake temperature should be provided to warn the pilot.

Ch. 14 (Amend. 93/1, Eff. 8.3.93)

3 - What are the differences in the standards and what do these differences result in?: [Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

Paragraph 25.729...	Description	Difference and result
(b)	Landing gear lock	The JAR additionally requires a positive means to keep the landing gear and doors in the correct retracted position unless extending the gear and doors at any flight speed is not hazardous. This results in the need for uplock mechanisms that will function in the event that the primary retraction energy is lost, or in robust gear and door mechanisms that can withstand deployment at any flight speed. The requirement is not overly stringent since loss of primary retraction energy is an expected event. The uplock mechanism is preferred since extension of the landing gear will increase fuel consumption due to increased drag.
(e)	Position indicator and warning device	The JAR refers to ACJ 25.729(e). The JAR further refines the definition of the indicator to: 1. be easily visible to the pilot or appropriate crew members, 2. indicate without ambiguity the position of the gear. In addition the JAR requires that the indicator also provide similar position information about the associated landing gear doors. These additions simply state what should be intrinsic to any prudent landing gear indication design.

(e)(5)		Regarding false or inappropriate alerts, the FAR uses the word "eliminate" while the JAR uses the more practical word "minimise." If taken literally, the FAR requirement is overly stringent. While elimination of nuisance warnings is a worthy goal, it is virtually impossible to actually never have a nuisance warning unless the system is unable to provide any warning. The JAR requirement is more subjective but attainable and embraces any improvements in warning system technology.
(e)(7)		The FAR does not contain this subparagraph. The subparagraph requires an indication if the landing gear position does not agree with the selector lever position. This is consistent with prudent landing gear indication design.
(f)	Protection of equipment from rolling stock threats	In addition to protection of equipment in the wheel well, the JAR includes protection of equipment on the landing gear. This results in analysis and protection of equipment that is not just in the wheel well but also on the landing gear either gear retracted or extended. This is reasonable since equipment on the lower part of the landing gear is always near the tire and therefore should be considered.
(f)(1)	Tire burst, loose tread	The JAR deletes the FAR condition ", unless it is shown that a tire cannot burst from overheat;" and refers to ACJ 25.729(f) which states that wheel fuse plugs are not a complete means of compliance to protection of essential equipment from tire burst. This results in removal of two possible, however not very viable, compliance methods i.e. showing the tire will not burst from overheat or the use of wheel fuse plugs.
(f)(3)	Brake temp.	The FAR does not contain this subparagraph. The JAR requires protection of equipment from possible wheel brake temperatures and refers to ACJ 25.729(f) which suggests an indication of brake temperature should be provided to the pilot. This results in an analysis of equipment that could be exposed to heat from the brake or installation of a brake heat indication system. With regard to safety and cost, locating essential equipment away from possible brake heat is superior to an additional indication system which has its own failure mode and maintenance issues.

4 - What, if any, are the differences in the means of compliance? [Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

If taken literally, each regulatory difference identified in 3 above involves a different means of compliance. Typically the JAR has additional requirements that would involve additional means of compliance. These literal differences are:

Paragraph 25.729...	Literal compliance difference
(b)	The JAA is more stringent requiring each retractable landing gear and separately actuated door to have a positive uplock or, be able to extend or open into the air stream at any flight speed without causing a hazard. Compliance would be demonstrated by system description or stress analysis.
(e)	For the JAA each indicator must be visible to the appropriate crew members and not be ambiguous regarding gear position. The JAA requirement is somewhat redundant since an indicator that is not visible or is ambiguous would not perform its intended function per 25.1301. The JAA is more stringent requiring the indicator to also indicate associated landing gear door position. Strict compliance with either regulation would require an explicit UP (and for the JAR, Doors Closed) indication. Current "quiet, dark cockpit" philosophy displays gear down, gear disagree, and door open only but not gear up or doors closed. Compliance is demonstrated by system description and failure modes and effects analysis.
(e)(5)	The FAA is more stringent requiring the aural warning system to eliminate false or inappropriate alerts. Compliance is demonstrated by failure mode and effects analysis with an understanding that eliminate means "very low probability."
(e)(7)	The JAA is more stringent requiring an indicator if the landing gear position does not agree with the selector lever position. Compliance is demonstrated by system description and failure mode and effects analysis.
(f)(1)	The JAA is more stringent. The JAR omits the FAA condition which excludes consideration of tire burst if it can be shown that the tires will not burst from overheat, and the JAR refers to an ACJ which excludes wheel fuse plugs as a complete means of compliance. Note that the term "explosion" used in the ACJ is referring to tire burst and not an actual tire explosion caused by the combustion of oxygen and rubber hydrocarbons. Additional means of compliance such as separation analysis, robust design or test are required. (The FAA has taken the same position in letter WE-130, "Tire Burst Protection for Essential Equipment Located in Wheel Wells – 737 Airplane," C.R. Hanks to B.L. Carter, dated Nov. 14, 1966

	and per AC 25-22 in an FAA memorandum dated Dec. 4, 1997.)
(f)(3)	The JAA is more stringent in requiring protection of essential equipment from the damaging effects of possible wheel brake temperatures. Compliance is demonstrated by separation analysis, thermal analysis, or, as suggested in the ACJ, a brake temperature indication system.

In addition to the regulatory differences described above, the FAA and JAA have different advisory material pertaining to 25.729 as follows:

FAA AC 25-22, Certification of Transport Airplane Mechanical Systems, dated March 14, 2000. Summaries of the relevant compliance methods are:

25.729(f)(1) The intent is to protect essential equipment from the effects of a tire burst regardless of the cause of the burst. The preamble to Amendment 25-78 refers to a tire burst as a sudden, sometimes violent, venting of the pressure from within a tire. With this in mind equipment in the wheel well is evaluated for its ability to withstand the effects of a bursting tire and design changes are often made to ensure that a single tire burst will not cause loss of critical functions.

25.729(e) This section is extracted from an FAA memorandum dated July 12, 1988, which addresses whether a backup gear position indication system is required. The section also contains portions of an FAA memorandum dated June 3, 1983, which addresses whether other regulations need to be considered when finding compliance to 25.729(e). (e.g. 25.1301 and 25.1309)

Landing Gear Slush Tests While not a specific regulation, this section is extracted from an FAA memorandum dated April 12, 1983, addressing the need for tests to ensure that the landing gear can be extended if joints should become frozen during the flight.

FAA AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes, dated June 3, 1999. Summaries of the relevant compliance methods are:

25.729(d) Flight tests should be conducted to demonstrate the ability of the landing gear and associated components, in their heaviest configuration to properly retract and extend in 1 g flight, normal yaw angles, and airspeeds up to V_{LO} Additionally an engine out gear retraction time demonstration procedure is described.

25.729(e) A combination of flight tests, ground tests, and analysis may be used to show compliance with the intent of 25.729(e)(2) through (e)(4).

JAA ACJ 25.729(e) Retracting Mechanism (Interpretive Material), discusses 1) the conditions for and color of light indicators, 2) aural warning with any high lift or engine configurations, 3) avoidance of nuisance activation, 4) inhibition of the warning at

appropriate flight phases, 5) means for deactivation by the flight crew. In particular ACJ 25.729(e)(1)(b) recommends a warning light consistent with JAR 25.1322 ("warning" means a red light) be illuminated at all times except when the landing gear and its door are secured in the landing or retracted position.

JAA ACJ 25.729(f) protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance), discusses 1) exclusion of wheel fuse plugs as complete compliance method, 2) recommendation of a wheel brake temperature warning to the pilot.

Excluding 25.729(f), the actual Boeing experience is that there has been only two regulations where we have encountered difference in showing compliance between FAR 25.729(a) thru (e) and JAR 25.729(a) thru (e). One difference is the interpretation of 25.729(a)(1)(iii) where the FAA understands this to be a load consideration for structural integrity of mechanical elements and the JAA occasionally interprets this as a load condition under which the landing gear actuation system must operate. The other difference is JAR 25.729(e)(7) and ACJ 25.279(e)(1)(b) which suggest a red colored indication should be displayed whenever the landing gear are in transit. This is not an FAA requirement. It is not consistent that a normal landing gear retraction or extension illuminate a light that indicates "a hazard that may require immediate corrective action" per JAR 25.1322.

Regarding 25.729(f), there has been a significant difference in the means of compliance between the FAR and the JAR. Apart from the obvious wording differences and the additional requirement imposed by JAR 25.729(f)(3), since 1995 the JAA has imposed a Means of Compliance Certification Review Items (CRI) for JAR 25.729(f)(1) tire burst, and (f)(2) loose tread. The CRIs define specific interpretations of JAR 25.729(f)(1) and (2) and states that addressing the failure modes so defined would be an acceptable means to demonstrate compliance to the applicable airworthiness requirements. The defined failure modes are well beyond what has been acceptable for showing compliance to FAR 25.729(f). While the CRI is introduced as one acceptable means of compliance, Boeing efforts to introduce alternative failure models based on service experience and previous airplane certifications were strongly resisted because the JAA wanted to standardize compliance to JAR 25.729(f) with all manufacturers. Standard means of compliance is preferred by Boeing but it should have a basis in analysis and service experience.

5 – What is the proposed action? [Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

FAR/JAR 25.729(a) through (f) can be treated as Category 1 and basically enveloped. For the most part the additional requirements in the JARs simply emphasize what should be good design practice. Proposed advisory material was developed from the

existing FAA AC and JAA ACJ material and is included under "6. Harmonized Standard".

Proposed Future Action.

As a separate future exercise the following items should be accomplished:

a. Modify 25.729(a)(1)(iii) to clarify that an explicit indication is not required to indicate landing gear up and doors closed.
b. Incorporate minor wording changes as proposed under "10. What other options..." of this report. These changes will clarify the intent of the regulation and avoid words that have specific meaning beyond the intent of the regulation.
c. Advisory material should be expanded to incorporate the intent of the JAA CRIs with some adjustments to allow for simpler analysis of tire and wheel threats.

This proposed future effort (a., b., and c.) should be treated as Category 3 since it is anticipated that significant negotiations will be required to accomplish this action.

6 - What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

25.729 Retracting mechanism

(a) *General.* For airplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for--

(i) The loads occurring in the flight conditions when the gear is in the retracted position;

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_s (with the flaps in take-off position at design take-off weight), occurring during retraction and extension at any airspeed up to 1.6 V_{s1} with the wing-flaps in the approach position at design landing weight, and

(iii) Any load factor up to those specified in § 25.345 (a) for the wing-flaps extended condition.

(2) Unless there are other means to decelerate the airplane in flight at this speed, the landing gear, the retracting mechanism, and the airplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_C.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing maneuvers prescribed for the airplane in addition to the

conditions of airspeed and load factor presented in paragraphs (a)(1) and (2) of this section.

(b) *Landing gear lock.* There must be positive means to keep the landing gear extended in flight and on the ground. There must be positive means to keep the landing gear and doors in the correct retracted position in flight, unless it can be shown that lowering of the landing gear or doors, or flight with the landing gear or doors extended, at any speed, is not hazardous.

(c) *Emergencyoperation.* There must be an emergency means for extending the landing gear in the event of--

(1) Any reasonably probable failure in the normal actuation system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator and warning device.* If a retractable landing gear is used, there must be a landing gear position indicator easily visible to the pilot or to the appropriate crew members (as well as necessary devices to actuate the indicator) to indicate without ambiguity that the retractable units and their associated doors are secured in the extended (or retracted) position. The means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by paragraph (e)(2) of this section such that it could be operated instinctively, inadvertently or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to minimize false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(7) A clear indication or warning must be provided whenever the landing gear position is not consistent with the landing gear selector lever position.

(f) *Protection of equipment on landing gear and in wheel wells.* Equipment that is essential to the safe operation of the airplane and that is located on the landing gear and in wheel wells must be protected from the damaging effects of--

(1) A bursting tire;

(2) A loose tire tread, unless it is shown that a loose tire tread cannot cause damage; and

(3) Possible wheel brake temperatures.

AC 25.729-1X or ACJ 25.729–Transport Airplane Landing Gear Retracting Mechanisms (Interpretive Material)

(Example written as an AC for the FAA)

1. PURPOSE. This Advisory Circular (AC) provides guidance material for use as an acceptable means of demonstrating compliance with the landing gear retracting mechanism requirements of the Federal Aviation Regulations (FAR) for transport category airplanes. Like all AC material, this AC is not, in itself, mandatory and does not constitute a regulation. It is issued to provide an acceptable means, although not the only means, of compliance with the rules. Terms used in this AC, such as "shall" and "must," are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described herein is used. While

these guidelines are not mandatory, they are derived from extensive Federal Aviation Administration and industry experience in determining compliance with the pertinent FAR. This advisory circular does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

2. RELATED DOCUMENTS

a. Related Federal Aviation Regulations. Section 25.729 of the FAR, as amended through Amendment 25-xx, and other sections relating to landing gear retracting mechanism installations. Sections which prescribe requirements for the design, substantiation, and certification of landing gear retracting mechanisms include:

§ 25.111	Takeoff path
§ 25.301	Loads
§ 25.303	Factor of safety
§ 25.305	Strength and deformation
§ 25.307	Proof of structure
§ 25.333	Flight envelope
§ 25.471	General [Ground loads]
§ 25.561	General [Emergency Landing Cond.]
§ 25.601	General [Design and Construction]
§ 25.603	Materials
§ 25.605	Fabrication methods
§ 25.607	Fasteners
§ 25.609	Protection of structure
§ 25.613	Material strength properties
§ 25.619	Special factors
§ 25.621	Casting factors
§ 25.623	Bearing factors
§ 25.625	Fitting factors
§ 25.729	Retracting mechanism
§ 25.777	Cockpit controls
§ 25.779	Motion and effect of cockpit controls
§ 25.781	Cockpit control knob shape
§ 25.863	Flammable fluid fire protection
§ 25.869	Fire protection: systems
§ 25X899	Electrical bonding, etc. (JAA only)
§ 25.1301	Function and installation.
§ 25.1309	Equipment, systems and installations.
§ 25X1315	Negative acceleration. (JAA only)
§ 25.1316	System lightning protection.
§ 25.1322	Warning, caution and advisory lights.
§ 25.1353	Electrical equipment and installations.
§ 25.1357	Circuit protective devices.
§ 25X1360	Precautions against injury. (JAA only)

§ 25.1435	Hydraulic systems.
§ 25.1515	Landing gear speeds.
§ 25.1555	Control markings.
§ 25.1583	Operating limitations.
§ 25.1585	Operating procedures.

b. Advisory Circulars (AC's).

AC 20-34D,	Prevention of Retractable Landing Gear Failures
AC 23.729-1,	Landing Gear Doors and Retraction Mechanism (For information only)
AC 25.1309-1A	System Design and Analysis
AC 25-7A	Flight Test Guide for Certification of Transport Category Airplanes
AC 25-22	Certification of Transport Airplane Mechanical Systems
AC 43.13-1A	Acceptable Methods, Techniques and Practices – Aircraft Inspection and Repair.

c. Federal Aviation Administration Orders.

Order 8110.4A	Type Certification Process

Advisory Circulars and FAA Orders can be obtained from the U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.

d. Society of Automotive Engineers (SAE) Documents.

SAE AIR-4566	Crashworthiness Landing Gear Design
SAE ARP-1311A	Landing Gear - Aircraft
ISO 7137	Environmental Conditions and Test Procedures for Airborne Equipment (not an SAE document but is available from the SAE)

These documents can be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania, 15096.

e. RTCA Documents.

RTCA/DO-160D	Conditions and Test Procedures for Airborne equipment, Issued July 12, 1996.
RTCA/DO-178B	Software Considerations in Airborne Systems and Equipment Certification, Issued December 1, 1992

Copies of RTCA documents may be purchased from the RTCA Inc., 1140 Connecticut Avenue NW, Suite 1020, Washington, D.C. 20036.

f. Military Documents.

MIL-STD-810 Environmental Test Methods and Engineering Guidelines

This document can be obtained from the Department of Defense, DODSSP, Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

3. BACKGROUND.

Effective February 1, 1965, Part 25 was added to the Federal Aviation Regulations (FAR) to replace Part 4b of the Civil Air Regulations (CAR). Sections 4b.334 and 4b.334-2 of the CAR, became §25.729 of the FAR for landing gear retracting mechanism.

(1) Amendment 25-23 (April 8, 1970) added a wheel rotational speed based on a factored takeoff speed of 1.3 to be used for load computations under § 25.729(a)(1)(ii) and changed the reference from § 25.345 to § 25.345(a) under § 25.729(a)(1)(iii).

(2) Amendment 25-42 (January 16, 1978) clarified the rule and made minor editorial changes to § 25.729(e)(3).

(3) Amendment 25-72 (July 20, 1990) amended the rule. It made editorial changes and deleted reference to § 25.67(e) under § 25.729(e)(4), since § 25.67 no longer existed.

(4) Amendment 25-75 (December 5, 1991) revised §25.729(e)(2) through (e)(6) to state objectives without stating how the requirements were to be met; thus allowing manufacturers to use their ingenuity in designing systems to minimize the occurrence of nuisance and inappropriate aural warnings.

(5) Amendment 25-XX (date) **[Insert amendment number and date when published]**, revised §25.729(a) through (f) to harmonize FAA Standards with JAA Standards for Transport Category Airplanes. The revision was accomplished by taking the envelope of the two requirements.

4. DISCUSSION

a. Intent of Rule. (Reference §25.729 Retracting mechanism) This rule provides minimum design and certification requirements for landing gear actuation systems to address:

(1) Structural integrity for the nose and main landing gear, retracting mechanism(s), doors, gear supporting structure for loads imposed during flight,
(2) Positive locking of the kinematic mechanisms,
(3) Redundant means of extending the landing gear,
(4) Demonstration of proper operation by test,
(5) Gear up-and-locked and down-and-locked position indications and aural warning.
(6) Equipment damage from tire burst, loose tread, and wheel brake temperatures.

b. Demonstration of Retracting mechanism Proper Functioning (Reference §25.729(d) *Operation test*) Guidance addressing flight testing used to demonstrate compliance with this section may be found in Advisory Circular (AC) 25-7A, Flight Test Guide for Transport Category Airplanes, chapter 4, section 4, paragraph 52, issued June 3, 1999.

c. Retracting Mechanism Indication: (Reference §25.729(e) *Position indicator and warning device*).

(1) When light indicators are used, they should be arranged so that-
(a) A green light for each unit is illuminated only when the unit is secured in the correct landing position.
(b) A warning light consistent with § 25.1322 is illuminated at all times except when the landing gear and its doors are secured in the landing or retracted position.
(2) The warning required by § 25.729(e)(2) should preferably operate whatever the position of wing leading- or trailing-edge devices or the number of engines operating.
(3) The design should be such that nuisance activation of the warning is minimized, for example-
a. When the landing gear is retracted after a take-off following an engine failure, or during a take-off when a common flap setting is used for take-off and landing;
b. When the throttles are closed in a normal descent; or
c. When flying at low altitude in clean or low speed configuration (special operation).
(4) Inhibition of the warning above a safe altitude out of final approach phase either automatically or by some other means to prevent these situations is acceptable, but it should automatically reset for a further approach.
(5) Means to de-activate the warning required by § 25.729(e) may be installed for use in abnormal or emergency conditions provided that it is not readily available to the flight crew, i.e. the control device is protected against inadvertent actuation by the flight crew and its de-activated state is obvious to the flight crew.

d. Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance): (Reference §25.729(f) *Protection of equipment on landing gear and in wheel wells*),

(1) The use of fusible plugs in the wheels is not a complete safeguard against damage due to tire explosion.

(2) Where brake overheating could be damaging to the structure of, or equipment in, the wheel wells, an indication of brake temperature should be provided to warn the pilot.

f. Definitions. For definitions of V_S, V_{S1}, and V_C, see 14 CFR Part 1, section 1.2, titled Abbreviations and symbols.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

The harmonized rule merges existing FAR/JAR requirements and industry practices which have resulted in safe aircraft systems with proven service experience. The proposed advisory material for § 25.729 collects existing advisory material which should facilitate consistent compliance methods across the industry.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The level of safety will be improved for landing gear retracting mechanisms certified to the requirements of the FAA because the proposed standard retains all of the existing FARs and adds the minor clarifications that are found in the JARs.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

For 25.729(a) through (d), and (f) the proposed standard is not significantly changed and therefore will maintain the same level of safety.
For 25.729(e) the proposed standard is based on recent amendments (FAA Amendment 25-75, Dec. 5, 1991 and JAA Change 14, Amendment 93/1, March, 8, 1993) which were incorporated to make the regulation more compatible with the design of modern jet aircraft. As a result the proposed standard will maintain the same level of safety.

10 - What other options have been considered and why were they not selected?: [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]

The following options to the regulation were considered but were not selected because this exercise is using the "fast track" process which involves simple enveloping of the more stringent of the FAA or JAA regulation. Efforts should be made in the future to consider the following potential options to the regulation.

The following paragraph numbers identify options that were considered for the proposed regulation and advisory material:

Regulation:

§ 25.729(a)(1)(iii)

A sentence should be added to clarify that this regulation applies to the strength of the landing gear retracting mechanism, wheel well doors, and supporting structure and does not require that the landing gear actuation system must be able to retract the landing gear under these loading conditions. The Flight Test Guide for Certification of Transport Category Airplanes, FAA AC 25-7A, Section 4 Landing Gear, specifically identifies that demonstration of landing gear actuation system capability be conducted at near 1 g flight.

§ 25.729(c)

The word "alternate" should replace the word "emergency" in describing the secondary means of extending the landing gear. Use of the secondary landing gear extension means should not imply an emergency situation.

§ 25.729(c)(1)

The term "reasonably probable" should be replaced by "single" in describing the failures that must be addressed by the alternate means of extending the landing gear. The word "probable" has connotations from 25.1309 that may be construed to mean single failures that are less likely than probable need not be considered. Jams of primary joints are excluded since a complete jam will prevent extension of the single affected landing gear by normal or alternate means. The term jam includes elements that hang up the gear as well as excessive joint friction. The intent of this subparagraph would then be similar to FAR 25.671(c)(1).

§ 25.729(e)

The rule could be generalized to require indication to the pilots of landing gear position status rather than specifically the extended or retracted positions. Modern quiet, dark flight decks usually do not have a specific indication for landing gear "secured in the retracted position."

§ 25.729(e)(XX)

A paragraph should be added to emphasize the specific need for the ability to determine individual gear extended status regardless of gear command status.

§ 25.729(e)(7)

Text should be modified to remove the word "warning" because "warning" per 25.1322 has a specific meaning that is not consistent with normal operation of the landing gear. The text should be moved to group the "indication" requirements together.

§ 25.729(f)

The word "essential" should be replaced by the word "required." The word "essential" has taken on a criticality connotation under D0-178A, Software Considerations in Airborne Systems and Equipment Certification, paragraph 5.2.1, and it implies the rule only considers equipment damage from tire failures that would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions and that consequences of greater criticality are not considered. This is not the intent of the rule.

Advisory Material: (Ref: Current JAR ACJ 25.729(e) and (f)

AC 25.729-1X paragraph 4.(c)(1)
To account for the increased use of programmable display screens in the flight deck, the words "Light indicators..." should be replaced by "Landing gear position indicators..."

AC 25.729-1X paragraph 4.(c)(1)(a)
The words "light" and "illuminated" should be replaced by "colored indicator" and "displayed" respectively to include other indicator methods such as programmable display screens.

AC 25.729-1X paragraph 4.(c)(1)(b)
The word "light" should be replaced by "indicator" and the meaning of the text should be modified to allow the multiple color options and display timing allowed by modern programmable display screens. Per § 25.1322, the word warning means "a hazard which may require immediate corrective action" and illumination of a warning light is not desirable for any time the gear position is in transit. The text should include provisions for indicators, such as lights, that do not have multiple color capability.

AC 25.729-1X paragraph 4.(c)(2)
The word "whatever" should be replaced by "independent of" to more accurately convey the intent.

AC 25.729-1X paragraph 4.(c)(3)
The introduction text should be revised to not repeat § 25.729(e)(5) but give examples of false or inappropriate alerts.

AC 25.729-1X paragraph 4.(c)(5)
The text should be revised to be less redundant and more aligned with § 25.729(e)(4).

AC 25.729-1X 4.(d)(1)
The word "explosion" should be replaced by the word "burst." Explosion implies the combustion of oxygen and hydrocarbons and is not the intent of the text. Protection from tire explosion is addressed by § 25.733(e).

AC 25.729-1X 4.(d) should be extensively modified because §§ 25.729(f)(1) and (2) are vague. The efforts by the JAA, via Certification Review Items (CRIs), to standardize the compliance methods for tire burst and loose tread are commendable but have been inconsistent by offering a mixture of definitions either of the particular threat or of the

damage zone caused by the threat. It has become clear that there is a wide array of experience among manufacturing and certification agencies on what the definition of a tire burst, or a thrown tread is, i.e. what size, how fast, how often, what energy transfer. Due to the complexity of the issue and the constraints of the "fast track" process, the proposed standard has not attempted to change the existing tire threat standards. In a separate harmonization effort, the advisory material should be revised to prioritize the 25.729(f)(1) and (2) compliance approach by emphasizing separation and damage zones and only trying to quantify the threat definition as a last resort.

AC 25.729-1X paragraph 4.(d)(2)
The text should be modified to reflect that brake temperature indication to the flight crew should be provided only if the combination of damaged equipment would prevent continued safe flight and landing. Damage to individual pieces of equipment or structure is acceptable if safe flight and landing capability are not jeopardized.

In addition to the changes considered for the above regulation and advisory material paragraphs, the following is a summary of policy material from the FAA that was reviewed for inclusion in the new AC. In most cases this policy material was generated in response to specific proposed designs, and was thus not appropriate for inclusion in the proposed advisory material. However, the policy material is still valid and details for the following topics can be found in AC 25-22, Certification of Transport Airplane Mechanical Systems: (issued March 14, 2000).

1. Landing Gear Slush Tests
2. Landing Gear Position Indication System - "Backup Requirement
3. Flap System/Landing Gear Warning System Tie-In
4. Landing Gear Position Indication System
5. Protection of Equipment on Landing Gear and in Wheel Wells

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Airplane manufacturers are primarily affected although the proposed standard for § 25.729 is not significantly changed from the existing regulations. Future development of a compliance method for §§ 25.729(f)(1) and (2) would benefit manufacturers that currently spend considerable time and money in evaluating tire burst and loose tread consequences.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

FAA AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes, FAA AC 25-22, Certification of Transport Airplane Mechanical Systems (includes policy letters), JAA ACJ 25.729(e), Retracting Mechanism (Interpretative Material), and § 25.729(f), Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance), are desirable to retain however they should be retained separately as advisory material. The proposed advisory material includes information from these ACs and ACJ's. A proposed preamble for § 25.729 follows:

PREAMBLE

SUMMARY: This notice proposes to harmonize the FAA and JAA requirements for landing gear retracting mechanisms. This action is in response to the Aviation Rulemaking Advisory Committee (ARAC) Mechanical Systems Harmonization Working Group recommendation to harmonize paragraph 25.729 of the Joint Aviation Requirements (JAR) with § 25.729 of the Federal Aviation Regulations (FAR).

GENERAL DISCUSSION

The intent of this rule is to combine the requirements of the Federal Aviation Regulations (FAR)section 25.729, and the Joint Aviation Requirements (JAR) 25.729 into one rule. The rule format and wording is identical to the existing JAR requirements. Appropriate advisory material from AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes; JAR ACJ 25.729(e), Retracting Mechanism (Interpretative Material); and ACJ 25.279(f), Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance) is included.

Changes to Existing FAR/JAR Text

Because of the "fast track" process, no changes were made to the existing FAR/JAR text. In all cases the more stringent of the FAR or JAR wording was incorporated to create the following regulations and advisory material.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

[]

Existing FAA advisory material pertaining to FAR 25.729 is:

1. AC 25-7A, Flight test Guide for Certification of Transport Category Airplanes, dated June 3, 1999.
2. AC 25-22, Certification of Transport Airplane Mechanical Systems, dated March 14, 2000.

Existing JAA advisory material pertaining to JAR 25.729 is:

1. ACJ 25.729(e) - Retracting Mechanism (Interpretative Material)
2. ACJ 25.729(f) - Protection of Equipment on Landing Gear and in Wheel Wells (Acceptable Means of Compliance)

This material is useful and should be updated to the proposed rule. Portions of this material are included in the proposed AC 25.729-1X

14 - How does the proposed standard compare to the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

"Due to their commitments as ICAO members the US and all JAA countries converted ICAO requirements into their airworthiness codes. So both the JAR and FAR 25 at least fulfill the ICAO minimum standards. As the proposed standard does not decrease the level of safety of FAR or JAR 25, it is in line with ICAO Annex 8 "Airworthiness of Aircraft"."

15 - Does the proposed standard affect other HWG's? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]

No, however, for the future development of advisory material defining tire burst and loose tread models, the definition of thrown tire tread should be coordinated with the definition being developed for FAR/JAR 25.963(g) advisory material however, because

§ 25.729(f) pertains to systems and § 25.963(g) pertains to wing structure, the definitions may not necessarily have to be identical.

16 - What is the cost impact of complying with the proposed standard? [Is the overall cost impact likely to be significant, and will the costs be higher or lower? Include any cost savings that would result from complying with one harmonized rule instead of the two existing standards. Explain what items affect the cost of complying with the proposed standard relative to the cost of complying with the current standard.]

The proposed new standard will reduce the overall cost and time of the joint certification process and will not increase cost for any present major manufacturer that has a service demonstrated safety record.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]

The "Fast Track" process is appropriate for the scope of this harmonization effort.

For future clarification of the rule and existing advisory material and the future development of advisory material for § 25.729(f), the fast track process is probably not appropriate based on the extent of the proposed changes and the complexity of compliance demonstration for § 25.729(f) during the 737NG and 767-400ER programs. The eventual advisory material for § 25.729(f) will require extensive negotiation and data sharing requiring several face to face meetings. In addition, the experience and data from tire manufacturers and airframe manufacturers other than Boeing should be considered prior to defining the final § 25.729(f) means of compliance advisory material.

Revised by M.Wahi on 1-26-2000.

FAA Action: Placed on the AVS “Do By Other Means” list, dated June 14, 2005.